NOV 4 1927

VOLUME XLV NOVEMBER, 1927 NUMBER 5

Medical Library

Surgery, Gynecology and Obstetrics

WITH

International Abstract of Surgery

Official Journal of the American College of Surgeons

EDITORIAL STAFF

FOR AMERICAN COLLEGE OF SURGEONS

WILLIAM J. MAYO, M.D., Rochester

GEORGE W. CRILE, M.D., Cleveland
HARVEY CUSHING, M.D., Boston
GEORGE E. ARMSTRONG, M.D., Montreal
E. WYLLYS ANDREWS, M.D., Chicago
JOHN L. PORTER, M.D., Chicago
J. BENTLEY SQUIER, M.D., New York

JOHN M. T. FINNEY, M.D., Baltimore
WALTER W. CHIPMAN, M.D., Montreal
RUDOLPH MATAS, M.D., New Orleans
FREDERIC A. BESLEY, M.D., Chicago
WALLACE I. TERRY, M.D., San Francisco
WILLIAM R. CUBBINS, M.D., Chicago

WILLIAM H. WILMER, M.D., Baltimore

FOR THE BRITISH EMPIRE

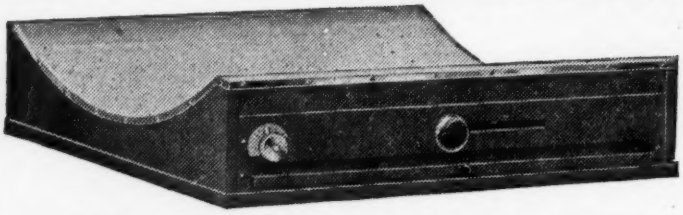
SIR ARTHUR MAYO-ROBSON, K.B.E., C.B., C.V.O., D.Sc., London
SIR BERKELEY MOYNIHAN, K.C.M.G., C.B., Leeds
SIR HAROLD J. STILES, K.B.E., F.R.C.S., Edinburgh
J. RUTHERFORD MORISON, M.B., F.R.C.S., Newcastle-on-Tyne
THOMAS W. EDEN, M.D., F.R.C.S., London
SIR WILLIAM I. DEC. WHEELER, M.D., F.R.C.S.I., Dublin

FRANKLIN H. MARTIN, M.D., MANAGING EDITOR
ALLEN B. KANAVEL, M.D., ASSOCIATE EDITOR
SUMNER L. KOCH, M.D., ABSTRACT EDITOR LOYAL DAVIS, M.D., ASSISTANT EDITOR

EDITORIAL AND BUSINESS OFFICES: 54 East Erie St., Chicago, Illinois, U. S. A.
PUBLISHERS FOR GREAT BRITAIN: Bailliere, Tindall & Cox, 8 Henrietta St., Covent Garden, London, W. C., England

Published Monthly. Annual Subscription: United States and Canada, $12.00; Single Copy, $1.25; Foreign, $14.00.
Copyright, 1927, by The Surgical Publishing Company of Chicago.
Entered as second-class matter May 22, 1913, at the postoffice at Chicago, Ill., under the Act of Congress, March 3, 1879.

EVERY SURGEON NEEDS IT



BRADY'S POTTER-BUCKY DIAPHRAGM

No surgeon should operate without the best information on internal conditions that can be secured only when a Potter-Bucky Diaphragm is used in the X-Ray Laboratory. You should insist on your X-Ray man at least TRYING one to assure himself and yourself of the truth of this.

Gives especially fine detail on heavy parts such as spine, kidney, gall-bladder, pelvis, etc., impossible to secure in any other way. THE GREATEST AID TO FINE RADIOGRAPHY EVER PRODUCED. The smallest, neatest and most accurate Bucky made.

New model with many improvements, price $250.00, less 10 per cent cash discount for prompt payment. Try it and be convinced.

EVERYTHING IN X-RAY SUPPLIES

We carry a large stock of all X-Ray supplies, including Duplitized Films, Plates, Intensifying Screens, Developer, Dental Film Mounts, Developing Tanks, Coolidge Tubes, etc. Get our Price List and Discount before buying. Prompt shipment always.

GEO. W. BRADY & CO., 756 So. Western Ave., Chicago, Ill.

In Almost Every Case of

CANCER
RADIUM

IS GIVEN CONSIDERATION

RADIUM CHEMICAL CO.
(*Formerly of Pittsburgh*)
511 Fifth Avenue at Forty-Third St.
NEW YORK CITY

Any Amount of Radium in any Form of Applicator Furnished
Terms if Desired

To know the fundamental principles of handling and applying radium is essential

ATTEND COURSE OF INSTRUCTION ~ NEW YORK CITY

SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XLV NOVEMBER, 1927 NUMBER 5

SPLENECTOMY[1]

BY HERBERT Z. GIFFIN, M.D., ROCHESTER, MINNESOTA
Division of Medicine, Mayo Clinic

THE spleen is the largest lymphoid organ in the body and a reservoir of blood cells. Under exercise and in certain pathological conditions this reservoir extrudes blood into the circulation to maintain circulatory balance. By reason of its anatomical relationships, the balance chiefly affects the portal circulation.

For a long time the ancients believed that the spleen had some relationship to exercise, and thought that the wind of runners was improved by removal of the spleen. The basis for their opinion is not known. It was probably influenced by the prevalence of malarial splenomegaly, as this condition would obviously have an influence on exercise. Quite recently, hundreds of years later, Macht and Finesilver found that the speed of rats is increased after splenectomy. The still more recent work of Barcroft and his associates on the volume of the spleen indicates that the contents are expelled into the circulation during exercise. While this does not corroborate the theory of the ancients in its entirety, it does corroborate it so far as it pertains to the existence of some relationship between exercise and splenic function.

EXPERIMENTAL SPLENECTOMY

No attempt can be made in this paper to review the functions of the spleen, which, together with a complete discussion of the experimental work on the spleen up to 1918, are given by Pearce, Krumbhaar, and Frazier. The important effects of experimental splenectomy may be summarized as follows: (1) the occurrence of anæmia of the secondary type, (2) the production of leucocytosis, (3) an increase of resistance of the erythrocytes to hypotonic sodium chloride solution and other hæmolytic agents, (4) a lessened tendency toward hæmoglobinuria and jaundice after the administration of hæmolytic agents, (5) a decrease in the volume of the portal blood, (6) the conversion of the bone marrow into red marrow and an actual increase in the volume of the marrow which can hardly be explained as merely compensatory to the anæmia following splenectomy, and (7) hypertrophy of the lymphatic tissues which seems to be due principally to hyperplasia of the endothelial cells.

SPLENECTOMY IN MAN

The anæmia noted following experimental splenectomy performed in healthy animals is not ordinarily observed following splenectomy in man for pathological conditions of the spleen; however, mild anæmia has occurred as a result of splenectomy for simple tumors of the spleen in otherwise normal persons. Leucocytosis is almost always present following splenectomy in man. A slight increase in the resistance of the erythrocytes or, as in cases of hæmolytic jaundice, less marked fragility, has been repeatedly noted. The

[1] Read before the Minnesota Academy of Medicine, March 9, 1927.

jaundice of hæmolytic icterus disappears remarkably after splenectomy and the improvement of the portal circulation, probably an evidence of decreased volume of portal blood, is demonstrated by the disappearance of ascites and the decreased frequency of gastro-intestinal hæmorrhage. Hyperplasia of the lymphatic tissues has been seen occasionally during life and has been definitely found post-mortem following splenectomy in man. Also there is a definite increase in the reticulated cell count and in the number of platelets in the circulating blood after splenectomy for various diseases. The increase in the platelets is most marked following splenectomy for hæmorrhagic purpura. From the clinical study of cases, it can be said in general that the striking results of splenectomy are: (1) improvement in the anæmia, both of the secondary type and temporarily even of the primary type, (2) a great increase in the number of platelets and a modification of the various factors of coagulation in cases of hæmorrhagic purpura, (3) a lessened tendency toward jaundice in general, and its disappearance in cases of hæmolytic icterus, (4) evidence of improved portal circulation in cases in which cirrhosis of the liver is present, and (5) decreased amounts of urobilin and urobilinogen in the duodenal contents and the fæces, doubtless the result of absence of the products of hæmolysis in the spleen which before splenectomy were carried in high concentration to the liver.

In 1920, I reviewed a series of cases of splenectomy at the Mayo Clinic, especially with respect to operative mortality and post-operative duration of life. Since then papers have appeared by W. J. Mayo and Balfour. In view of recent experimental and clinical work, especially on hepatic function and hæmorrhagic disease, which have a bearing on the diseases associated with splenomegaly, it seems wise to summarize our experience again.

The diagnosis and classification of some of the diseases associated with splenomegaly is clear, but of others totally unsatisfactory. Little light has been shed on the differentiation of simple splenomegaly without anæmia, splenic anæmia, chronic septic splenomegaly, and cirrhosis of the liver. Not infrequently cases are seen that do not fall satisfactorily into any of these groups, and this fact together with the similarity in their pathology seems to indicate that they may have a common etiology. In most instances it can be argued that this etiology is infectious, probably due directly or indirectly to the ordinary pyogenic organisms, although the work of Hollins indicates that it may be due to the bacillus coli.

SPLENIC ANÆMIA

The diagnosis of splenic anæmia is obviously unsatisfactory in some cases; it is really based on exclusion, eliminating all other conditions which might simulate splenic anæmia, as hæmolytic jaundice, syphilitic splenomegaly, leucæmia in an aleucæmic stage, polycythæmia vera after hæmorrhage, and, so far as possible, chronic septic splenomegaly and cirrhosis of the liver. Not infrequently it cannot be determined in a given case whether the splenomegaly or the hepatic cirrhosis was primary. Difficulty is also encountered in the differential diagnosis of the cases grouped as splenic anæmia and those grouped as chronic septic splenomegaly, especially when an obscure form of sepsis, as primary portal thrombosis, is a complication.

One hundred twenty-three cases have been classified as splenic anæmia. The number of hospital deaths in this group was 15 (12.19 per cent). A hospital death means a death occurring while the patient remained in the hospital irrespective of length of stay. This number is not high in consideration of the poor condition of many of the patients, the size of the spleen, the frequent existence of dense adhesions, and the presence of more or less marked hepatic insufficiency. Operative deaths have been due chiefly to hæmorrhage, pneumonia, pulmonary embolism, and portal thrombosis. In one instance it was caused by subdiaphragmatic abscess. The average post-operative length of life of those who recovered from operation but died subsequently was approximately two and a half years. Of 108 patients who recovered from operation, records were obtainable concerning 103; 60 are still living and only 5 of these are in poor condition. Subsequent deaths were due to a

variety of causes, among them causes which had no direct relationship to the former condition, as epithelioma of the œsophagus, shock following operation for obstruction, carcinoma of the stomach, influenza with pneumonia, and gangrene of the leg. In fact, after ten deaths from apparently unrelated conditions are deducted, the number of subsequent deaths amounts to only 33 over a period of 19 years. The most striking feature in connection with the subsequent deaths is the frequency of postoperative gastric hæmorrhage. In twelve instances death seemed to be either directly or indirectly due to gastro-intestinal hæmorrhage. Fatal hæmorrhage occurred as long as 5 years after splenectomy in two cases. Recurrent postoperative hæmorrhage is doubtless evidence of advanced cirrhosis of the liver or some other form of portal obstruction. Sixty-three patients who were operated on five or more years ago recovered from operation. Of these, 34 were living more than 5 years after operation and 29 are still living, and of the group 9 have lived longer than 11 years, one of them 18 years after splenectomy, all in good health except one who has hemiplegia.

The fact that so many patients recovered and have lived so long in good health and that 55 of 60 living patients are in satisfactory condition, justifies splenectomy as a therapeutic measure in splenic anæmia. It is likely that the studies of hepatic function that are now being applied to these cases will result in a more accurate estimation of the operative risk and of the probable subsequent prognosis. It may be wise for the surgeon to be content with simple exploration instead of splenectomy in the face of marked retention of dye and the discovery at operation of advanced cirrhosis of the liver. This view is corroborated by the high operative and subsequent mortality in those cases which have been classified as primary cirrhosis of the liver with secondary splenomegaly.

CHRONIC SEPTIC SPLENOMEGALY

The cases that have been grouped as chronic septic splenomegaly are those in which splenomegaly has been accompanied by chronic attacks of some form of septic exacerbation over a period of years, for example, tonsillitis, furunculosis, phlebitis, primary portal thrombosis, ulcerative colitis, and ulcerative endocarditis. In such cases the spleen may be markedly enlarged and at the time of examination the features of the case may be characteristic of splenic anæmia. A group of 27 cases has been classified as chronic septic splenomegaly, and in this group there were 7 hospital deaths and 9 subsequent deaths. The majority of the hospital deaths were due to portal thrombosis. Of the subsequent deaths 5 were due either to cardiac disease or nephritis and 3 to hæmorrhage. Only two patients have remained well for a long period after splenectomy, one of them for 10 years and one for 17 years.

It is important to separate this group of cases from the group of splenic anæmia because of the high operative mortality in the former and because patients are rarely benefited for a long period by splenectomy.

CIRRHOSIS OF THE LIVER

Studies on the pathological changes of the liver have revealed so many bizarre and mixed types of cirrhosis that the clinician can no longer arbitrarily group his cases as portal or biliary. It is hoped that the recent studies on the liver will lead to a new classification. An estimation of hepatic function, if it can be made, should be an index of operative risk and subsequent prognosis. The cases I have grouped as cirrhosis of the liver have shown clinically, operatively or pathologically that disease of the liver was primary and splenomegaly secondary. These indications are in some instances not clear. There were 35 cases with 7 hospital deaths. The high operative mortality may be directly due to hepatic insufficiency. Reports on 26 cases are available; of 10 patients living, 9 are now in good or fair condition, but of these 10 the longest postoperative period is only 3 years, and the longest postoperative life in the entire group of 35 cases is 5 years, in the case of a patient now deceased. This is in contrast to 18 years in the case of a patient still living and well in the group of splenic anæmia.

The results of splenectomy in cirrhosis of the liver are clearly not satisfactory, and

some new basis for the operation in this group is necessary. Heretofore the size of the spleen has been the chief though not the sole consideration. It should not be concluded, however, that splenectomy is always contraindicated in cirrhosis of the liver. It may be decidedly beneficial if hepatic function is not too badly impaired. It is probably most effective in the occasional case of cirrhosis associated with evidence of hæmolytic activity, especially in the presence of marked enlargement of the spleen.

SYPHILITIC SPLENOMEGALY

The value of splenectomy in cases of syphilis of the liver and spleen, when medical treatment had been unsatisfactory, was pointed out in earlier papers. The operation doubtless removes a nidus which reinfects the diseased liver. Given an opportunity to heal, the syphilitic hepar lobatum is not likely to be deficient in function. The number of cases in this group is 10, with 1 hospital death and 2 subsequent deaths. One patient died 6 weeks after operation from portal thrombosis, the other 2 years afterward from pneumonia. All the others are living, 4 of them more than 10 years later. All are in excellent health except one who has developed carcinoma of the uterus. Treatment for the syphilis was promptly effective after splenectomy. Better results could not be desired.

HÆMOLYTIC JAUNDICE

The importance of the diagnosis of hæmolytic jaundice is now so well understood and the value of splenectomy so generally recognized that it is not necessary to elaborate on them. From the standpoint of diagnosis, it may be well to reassert the importance of increased fragility of the erythrocytes in this disease and the necessity of excluding hæmolytic jaundice in every suspected case of splenic anæmia. An occasional case of mild hæmolytic jaundice may show normal fragility, but it is still doubtful whether the erythrocytes in hæmolytic jaundice ever show increased resistance, except when an extreme degree of obstructive jaundice is present secondarily. Cases of cirrhosis with hæmolytic characteristics have been excluded from this group.

In a total of 81 cases, the hospital mortality was only 4.93 per cent. Hospital deaths were due to hæmorrhage, peritonitis, and uræmia. The number of patients in this group of whom reports are available is 75. Of this number only 7 have died since operation, and of the 68 living, 63 are in good health. Most of those who report themselves in only fairly good health show the constitutional debility occasionally seen in patients with hæmolytic jaundice. The subsequent deaths have been due to a variety of causes, most of which have been unrelated to the hæmolytic jaundice, such as gangrenous dermatitis, diabetic coma, cerebrospinal meningitis, and operation for gall stones. One patient is living 15 years after operation and 13 more than 9 years after operation. Our experience, therefore, indicates more clearly as time goes on the value of splenectomy in hæmolytic jaundice. The statistics are thoroughly satisfactory.

PERNICIOUS ANÆMIA

Between February 10, 1910, and January 1, 1927, a series of 62 patients with pernicious anæmia underwent splenectomy. The last operation was on June 16, 1925. Because of the fact that in recent years only an occasional patient with pernicious anæmia has been submitted to splenectomy, the postoperative records in this group are of greater value. The hospital mortality, as would be expected, was not high, the hospital deaths numbering 4 (6.4 per cent). Of the entire group 3 are still living, 1 a year and 8 months, another 3 years and 6 months, and the third 10 years after operation. The total duration of the disease in the last case is 11 years. Approximately 75 per cent of those who recovered from the operation lived less than 3 years afterward, with an average total duration of the disease of 2½ years. It may be significant, however, that 25 per cent of those recovering from operation lived more than 3 years, with an average total duration of the disease of more than 7½ years. The patient who is still living after 10 years had all the characteristics of pernicious anæmia including cord changes; the spleen, however, was large and evidences of hæmolysis were marked.

Nevertheless, the case could not be classified as one of hæmolytic jaundice. It has been thought that splenectomy is warranted in only an occasional case of pernicious anæmia, especially if the spleen is enlarged and there are evidences of active hæmolysis. It is, however, not impossible that splenectomy combined with other methods of treatment may eventually have a more significant place in the management of pernicious anæmia.

MYELOGENOUS LEUCÆMIA

In a few cases recorded in the early literature splenectomy was performed for myelogenous leucæmia. Practically all of these patients died from hæmorrhage, and in the light of experience and the nature of the disease it was quite logically concluded that splenectomy was definitely contra-indicated for myelogenous leucæmia. Following treatment by means of radium and roentgen-ray, however, it again seemed justifiable to submit a series of patients to splenectomy. From August 11, 1909, to January 1, 1927, 43 of the cases in which splenectomy was performed were classified as myelogenous leucæmia. In all except one of these cases, the operation was undertaken following treatment by radium or roentgen-ray or both. In three of the cases, splenomegaly had existed a long time, 6, 9, and 12 years, respectively, and at the time of examination the leucocyte counts were not high. The duration of splenomegaly and the history in these cases suggested that originally they were cases of simple splenomegaly or splenic anæmia and that the leucæmic process developed shortly before they came under observation. It is also possible that they were cases of a very chronic type of myelogenous leucæmia. These three patients who had had indications of the disease for a long time before operation did not fare better after operation than those whose disease had existed for a shorter period, nor did they live any longer. In one case the operation was recent. In the series of 43 cases, there was an operative mortality of three (6.97 per cent). The postoperative deaths were due to peritonitis, mesenteric thrombosis, and hæmorrhage with paralytic ileus. It is evident, therefore, that the operative mortality in cases of myelogenous leucæmia after treatment by means of radium and the roentgen-ray is lower than the average for splenectomy in general. In many of the early cases of this series, the disease was in an advanced stage and the patients lived a relatively short time after operation. It soon became clear that the spleen should not be removed if the patient had had myelogenous leucæmia for more than 2 years. In recent years, therefore, splenectomy has been confined to cases in which the previous history was short, the anæmia was not marked, and there was no evidence of acute leucæmia. In the entire group of 40 patients recovering from operation, the duration of life after operation was: more than 3 years in 5, more than 4 years in 2, more than 5 years in 2, and 7 years in 1. Twenty patients have lived longer than 2 years; of these 3 are still living. The total duration of the disease, pre-operative and postoperative, was 4 years or more in 18 cases.

Following splenectomy the patients are in better general health, in fact they are frequently able to do all of their former work, they are less anæmic and less likely to have recurrence of anæmia so common in myelogenous leucæmia, the leucocyte count remains quite consistently lower than before operation and when serious recurrence finally does appear, the terminal course is rapid. It is the practice in the Clinic to reduce the leucocyte count by means of radium or roentgen-ray when it rises above 75,000 or 100,000 following splenectomy. Roentgen-ray treatment seems to be more effective following splenectomy than radium application, and in an occasional case benzol is more effective than either. It is thus concluded that splenectomy is warranted in certain cases of myelogenous leucæmia although it is not to be urged. Patients who apparently have had the disease less than a year, and especially less than 6 months, and who do not show any evidence of acute exacerbations, can be promised prolongation of life and better general health with a fair degree of confidence.

LYMPHOCYTIC HYPERPLASIA

The cases in which the spleen showed excessive and diffuse lymphocytic hyperplasia,

pathologically, are included in this group. In 7 cases, there were no hospital deaths but 4 subsequent deaths. Three patients died in 3 years or less, as would be expected in cases of lymphosarcoma and Hodgkin's disease. One patient, however, lived 8 years; evidently the disease was of the benign type. Two other patients are known to be living 6 and 8 years, respectively, after splenectomy; at the time of operation there was no evidence of lymphatic disease elsewhere in the body and it is possible that splenectomy prevented the development of generalized lymphadenoma.

POLYCYTHÆMIA VERA

A patient with polycythæmia vera underwent splenectomy because of severe recurrent gastro-intestinal hæmorrhage. He is in good health more than 5 years later and has not required treatment for polycythæmia. I do not believe that this single experience justifies splenectomy in polycythæmia vera. There is at present no reason to assume that splenectomy in this disease inhibits the production of erythrocytes; however, our knowledge of the reactions between spleen and bone marrow is incomplete.

HÆMORRHAGIC PURPURA

A report of the early experience in the Mayo Clinic with splenectomy for hæmorrhagic purpura, and a general review of the literature up to May, 1925, has been published in previous articles. Between March 7, 1923, and January 1, 1927, the spleen was removed in 20 cases classified as hæmorrhagic purpura. The excellent results of this operation are approached only by its results in hæmolytic jaundice, and on account of the nature of the disease are much more spectacular. The indications for splenectomy in hæmorrhagic purpura are clear, and the most important factor in the decision is an accurate diagnosis. Acute aplastic anæmia with hæmorrhagic features, mild hæmophilia in which the coagulation factors are not altogether definite, acute leucæmia in which hæmorrhage has developed, and the rare splenomegaly of indeterminate type in which hæmorrhagic features have become superimposed, present the chief difficulties in this respect. In aplastic anæmia the anæmia usually precedes, by a considerable period, the development of hæmorrhage; all of the coagulation factors may be those found in hæmorrhagic purpura, and persistent and extreme leucopenia together with low reticulated cell count frequently become important factors in the diagnosis.

A diagnosis of acute leucæmia depends chiefly on a careful examination of the smears for immature cells; these may be found even though leucopenia is present. It is likely that patients with mild hæmophilia have occasionally been submitted to major surgical operations for other diseases and have recovered after more or less difficulty with postoperative bleeding. It is also likely that mild cases of hæmophilia do not show on examination all of the characteristic coagulation factors of the disease at a given time. There may, therefore, be difficulty in distinguishing between hæmophilia and hæmorrhagic purpura in certain cases. In fact, there is some doubt concerning the diagnosis in two cases recorded in the literature as hæmorrhagic purpura in which splenectomy was performed. In general, it should be remembered that in typical cases of hæmophilia, the coagulation time is prolonged, as estimated on blood drawn directly from the vein with a sharp needle, and the platelet count is normal. In hæmorrhagic purpura the platelet level on repeated platelet counts is low, the bleeding time prolonged, and the retractility of clot deficient. It has been demonstrated that a palpable or enlarged spleen is not essential in deciding whether to excise the spleen. In several cases reviewed in the literature and in our own series in which splenectomy was performed, the spleens were not palpable, and in one instance the spleen weighed less than normal. During a period of active hæmorrhage, it may be important not to delay operation until the blood count is brought to normal by means of transfusions. Cerebral hæmorrhage seems to be more likely to occur when the blood count has been artificially elevated to too high a level. This was noted at the Clinic prior to the days of splenectomy, and a recent case corroborates the observation.

In the 20 cases of splenectomy for hæmorrhagic purpura, there was no operative death. Splenectomy was accomplished with little difficulty from the surgical standpoint, and convalescence was in all instances except one characterized by prompt cessation of bleeding and remarkable improvement in the patient's general health. The exceptional patient, after a stormy convalescence, is now definitely improving one year after splenectomy. Shortly after operation intra-abdominal hæmorrhage occurred, probably from the ovaries, and a secondary abdominal operation was required. Bleeding from the uterus continued but was controlled for a short period, by curettage. Later radium was used in the uterus, and the presence of small uterine fibromyomata was suspected. All excessive bleeding ceased after the treatment with radium, and the patient now seems to be on the road to permanent recovery. Small purpuric and petechial areas continue to appear and the removal of the tonsils as a focus is indicated. This was an extremely severe case and the patient had been in poor health for 15 years. It demonstrates that optimism as to the ultimate result is justifiable even in the face of persistent postoperative hæmorrhage, provided the characteristics are clearly those of hæmorrhagic purpura.

The longest pre-operative duration of the disease was 15 years. The duration was 10 years or longer in 4 cases, 5 years or longer in 7, and 2 years or longer in 13. In only 4 cases did the disease exist less than 1 year before operation. In two it lasted only 2 months. The first patient was operated on 3½ years ago and has been in excellent health since convalescence. Nine patients have been in good health for 2 years or more. Slight epistaxis or petechial and purpuric eruption occurred during convalescence in 4 cases, and uterine bleeding was slightly excessive in 2 and markedly excessive in 1. In one case mild epistaxis and purpura recurred at long intervals for 1½ years after operation. As is now well known, the platelet count rapidly rises after splenectomy, sometimes temporarily to high levels, the bleeding time promptly is reduced, and other adjustments of the factor of coagulation gradually occur. There is a certain degree of variability in the bleeding time and the retractility of the clot in some cases for an indefinite period. Tonsillectomy in cases of hæmorrhagic purpura has ordinarily been followed by troublesome and even serious hæmorrhage, not infrequently necessitating transfusions, and it would therefore seem advisable to recommend splenectomy previous to the elimination of foci of infection. In view of the slight recurrence of hæmorrhagic symptoms in a few of the cases, the elimination of focal infection would seem to be of especial importance. I know of no instance in which the recurrence of petechial and purpuric areas has persisted following a careful elimination of foci.

The significance of the ultraviolet ray and the high vitamin diet in the treatment of thrombocytopenic purpura is not yet established, but they hold out some promise.

ACUTE APLASTIC ANÆMIA

Because of the remarkable effect of splenectomy in hæmorrhagic purpura and the contention of some observers that this disease and acute aplastic anæmia are expressions of the same cause, three cases of acute aplastic anæmia were submitted to splenectomy. The operation did not, however, affect the disease favorably. The patients died 1, 2, and 3 months, respectively, after operation. In view of the importance of an accurate differential diagnosis between acute aplastic anæmia and hæmorrhagic purpura, the following case is worthy of brief consideration.

A girl, aged 4, had been well and active until 1 week previous to admission, when purpura and petechiæ appeared. At the time of examination she was quite anæmic. The platelet count was low, the bleeding time prolonged, coagulation time by the Lee method normal, and prothrombin time prolonged. It was recognized that the features of the case were not clearly those of hæmorrhagic purpura, but after a month's observation splenectomy was decided on. The low platelet count and the leucopenia persisted after operation and the bleeding continued. Many transfusions were given. Because of severe infection of the tonsils, tonsillectomy was performed but this did not check the downward

course, and the patient died less than 3 months after the onset of the condition.

This case might be classified by some observers as a severe fulminating type of hæmorrhagic purpura, but a better case can be formulated for a diagnosis of acute aplastic anæmia. The fact that severe anæmia existed at the time of the first examination despite the short duration of bleeding, only 1 week, in the absence of free bleeding, would lead one to surmise that the patient had been anæmic prior to the development of purpura. It will be noted also that leucopenia was present at the time of the first examination and persisted even after transfusions and after splenectomy, and that the platelet count did not rise following splenectomy. These considerations, in view of the rapidly fatal termination, favor the diagnosis of acute aplastic anæmia.

UNUSUAL TYPES OF HÆMORRHAGIC DISEASE

The unusual types of hæmorrhagic disease are perhaps the most instructive and a discussion of them is necessary to a more complete conception of the difficulties and importance of diagnosis. Three cases are briefly reviewed.

The first patient, a woman, aged 44, had suffered from purpura for 8 years. She complained also of arthritic and muscular pains. There was no history of hæmophilia in the family. The various coagulation tests were normal. The platelet count was somewhat low. At the time of operation moderate enlargement of the spleen was noted. The platelet count rose temporarily and the bleeding ceased following splenectomy. Bleeding, however, recurred later and has persisted at intervals. The history of arthritis and myositis and the rather marked enlargement of the spleen without the coagulation features of hæmorrhagic purpura, aside from a somewhat low platelet level, lead to the conclusion that the case is one of chronic infectious splenomegaly with secondary purpura.

The second patient was a woman aged 28. Epistaxis, purpura and enlargement of the spleen began simultaneously 7 years before her admission. Gastro-intestinal hæmorrhage occurred later. A detailed study of the case showed a combination of the features of splenic anæmia and hæmorrhagic purpura. In favor of the diagnosis of splenic anæmia were the markedly enlarged spleen, gastro-intestinal hæmorrhage, and persistent leucopenia; in favor of the diagnosis of hæmorrhagic purpura were epistaxis, recurrent purpuric areas, low platelet count, delayed retractility of the clot, and a somewhat prolonged bleeding time. A year and a half after operation the patient is reported to be in a satisfactory condition, without the recurrence of bleeding.

The third patient, a girl, aged 9, gave a history of severe epistaxis since 14 months of age; there was no history of hæmophilia. The patient was extremely anæmic and required transfusions. Neither transfusions by the citrate method or by the direct method, nor intramuscular injections of whole blood or the various coagulants were effective in controlling the hæmorrhagic tendency. Before splenectomy the coagulation time (Lee and White method) was normal, the bleeding time was prolonged, and retractility of the clot was absent, but the platelet level was at all times normal or high. At the time of operation there was a great deal of hæmorrhage from the wound; ecchymosis and petechial hæmorrhagic areas were found within the abdomen and were also caused by handling the viscera. A great deal of local bleeding occurred following operation. The various coagulation tests and the platelet count were not at all affected by splenectomy. The patient continues to have recurrent epistaxis although so far at less frequent intervals than formerly. The case could not be satisfactorily classified as one of hæmophilia, hæmorrhagic purpura, or aplastic anæmia. Against the diagnosis of hæmophilia are the absence of family history, the normal coagulation time, the absence of involvement of the joints, and the fact that the patient had never bled excessively from cuts. Against the diagnosis of hæmorrhagic purpura are the very early onset of the disease at the age of 14 months, a persistently high platelet count, the fact that the platelet count did not rise following splenectomy, and the excessive postoperative bleeding from the wound. Against the diagnosis of aplastic anæmia are the long duration

TABLE I.—SPLENECTOMY: MISCELLANEOUS GROUP APRIL 1, 1904 TO JANUARY, 1, 1927.

Diagnosis	Patients	Deaths		Living
		Hospital	Subsequent	
Tuberculosis of the spleen	8*	1	1	4
Gaucher's disease (longest 18 years and 7 months)	6†	2	1	2
Ruptured spleen	4	1	0	3
Wandering spleen (longest 18½ years)	2	0	0	2
Indeterminate hæmorrhagic disease	3	0	0	3
Acute aplastic anæmia	3	0	3	0
Chronic aplastic anæmia	2	0	1	1
Chronic hæmolytic anæmia	1	0	0	1
Acute and subacute septic splenomegaly	2	0	2	0
Hodgkin's disease	1	0	1	0
Eosinophilia with splenomegaly	1	0	1	0
Neutrophilia with splenomegaly	1	1	0	0
Hæmorrhagic cysts	2	0	1	1
Hæmangioma	1	0	1	0
Secondary splenectomy	7	0	2	5
Unclassified	3	1	2	0

*Two patients not heard from.
†One patient not heard from.

of the anæmia, the persistently high leucocyte count, and the high platelet count.

Of these three cases the first is probably an instance of chronic septic splenomegaly with secondary purpura. In the second case splenic anæmia and hæmorrhagic purpura apparently developed simultaneously, and their relationship cannot be determined. An accurate diagnosis cannot be made in the third case; it had all the features of hæmorrhagic purpura except the persistently high platelet count.

The remaining cases are shown in Table I. Comment on them will not be attempted in this paper.

SUMMARY

This paper is in itself a summary of experience with splenectomy. The most important groups of cases are discussed in some detail. In two diseases, hæmolytic jaundice and hæmorrhagic purpura, the indication for splenectomy depends almost entirely on a satisfactory diagnosis. In all other groups the decision must be reached in each case by a consideration of the factors and circumstances concerned. In general the degree of chronic recurrent sepsis as indicated by the history and clinical data and estimations of hepatic function furnish important indexes for the advisability of splenectomy.

LARGE SINGLE (NON-PARASITIC) CYSTS OF THE SPLEEN

By EMIL NOVAK, M.D., F.A.C.S., Baltimore, Maryland
From the Gynecological Department of Johns Hopkins Medical School

CYSTS of the spleen are very rare, but as a rule they are readily amenable to surgical treatment. It seems worth while adding the report of one case of this type to the relatively small number already in the literature. The literature is brought up to date in a very recent paper by Frank, so that it need not be reviewed here.

CLASSIFICATION

In a general way three chief varieties of splenic cysts have been described.

1. *Dermoid cysts.* Only two instances of this type are recorded. It is of interest to note that the very first case of splenic cyst reported is said to have been of this type. It was found at autopsy by Andral in 1829.

2. *Parasitic cysts.* These cysts are due to infection by the echinococcus, are not so very rare where infection by this parasite prevails, and are commonly associated with similar cysts in other parts of the body.

3. *Non-parasitic cysts.* It is this form with which we are concerned in this paper. Up to 1921 Fowler had collected 91 cysts of this variety, and of these, 65 were classed as large and therefore of definite clinical importance. Since 1921, according to Frank, 8 additional cases have been added. Two were reported by Pribram, 1 by Gambill, 1 by Gosselin, 2 by Howald, and 2 by Frank in the recent paper mentioned. This makes a total of 73 cases, raised to 74 by the case herewith reported.

The classification of non-parasitic splenic cysts which has been quite generally adopted is that recommended by Fowler in 1921. In his paper of 1924 this author revises his classification somewhat, considering the following subdivision a better one:

1. Traumatic cysts: (a) usually large and unilocular, occurring as encysted hæmatoma, contents hæmorrhagic or serous (by far the most common variety); and (b) usually small, superficial, or deep-multiple, arising from inclusions of peritoneum (rare).

2. Inflammatory cysts: (a) tuberculous cysts (Charles H. Peck); and (b) snared off endothelium, usually superficially buried in the spleen as the result of perisplenitis (small and multiple) due to malaria, leishmaniasis, etc.

3. Degeneration cysts (solitary and large), arising from secondary changes in infarcted areas due to arterial degeneration or occlusion of blood vessels by emboli, with consequent necrosis of the pulp.

4. Dilatation cysts. Ectasis of splenic sinuses (polycystic disease, Coenen-Fowler). These are multiple and fused; the cysts usually riddle the organ.

5. Neoplastic types (lymphangioma, hæmangioma). It may not be possible to distinguish Group 4, which may be borderline in its tendencies, from this group. The differential criterion is still obscure.

While this classification is a suggestive one, at least until more is known as to the actual etiology of these tumors, it does not seem free from objections. Certainly it is better than Fowler's original classification, for there was no advantage in the division into the true and false varieties (cysts and pseudocysts). Whatever the etiology may be, we have to deal with a tumor mass containing fluid—a true cyst whether the origin be neoplastic or degenerative. The latter often reach a much larger size than do many of the so-called true cysts. It would seem wise, therefore, to abandon this fictitious distinction. Nor is there any obvious advantage in excluding from the neoplastic group (Group 5) the rare dermoids, for certainly these are of definitely neoplastic nature.

With the exception of a group of cases in which the history and the character of the cyst contents points definitely to trauma as the probable cause, one can usually only conjecture as to the mechanism of production involved in the individual case. Moreover, it is probably true that not a few cases attributed to trauma, especially those in which the

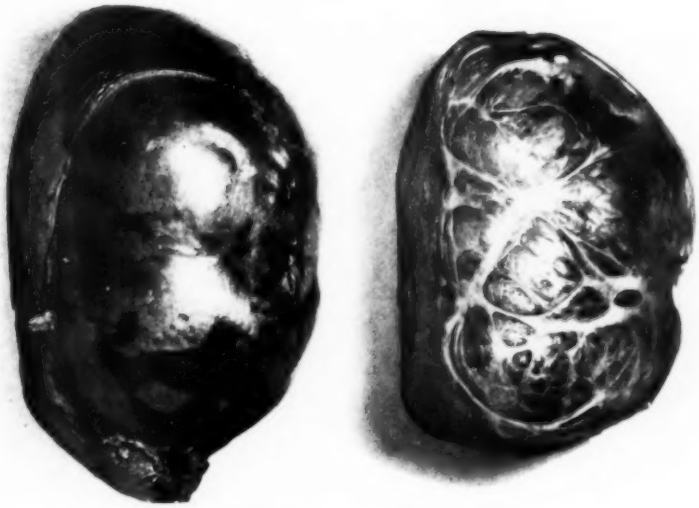


Fig. 1. Gastric surface of tumor mass, most of which is made up of large cyst.
Fig. 2. Interior of cyst wall, made up of peculiarly trabeculated fibrous tissue.

contents are serous instead of hæmorrhagic, are really due to some other cause, as yet unknown. The study of the embryology of the spleen may throw further light on the whole question, although I have not been able to obtain any clue on this point from the embryologists with whom I have discussed the matter.

Perhaps for the present, until more is known of the etiology of the non-parasitic type of cyst, it is best to attempt no subdivision, and merely to speak of the entire group as "large single" cysts of the spleen, as Pool and Stillman suggest.

CLINICAL CLASSIFICATION

Cysts of the type under discussion occur more often in women (about 65 per cent) than in men, and are most common between the ages of 20 and 50. They have been noted, however, in very young children, and even in the newborn infant.

The symptoms are not distinctive. Sometimes the presence of the tumor is the first thing observed by the patient. In most cases, when the tumor is of considerable size, there is discomfort and perhaps actual pain in the left hypochondriac region. In my case the pain was intermittent. At times pain is referred also to the left shoulder or the left side of the back. Dyspnœa may be complained of, together with some digestive disturbance, due to the pressure of the tumor upon the stomach.

DIAGNOSIS

The location of the tumor will usually suggest the spleen as a possible source, as the spleen occupies the left hypochondriac region, beneath the left costal margin. The tumor may push in toward the epigastrium, or its pedicle may rarely be so long as to allow it to float about in the lower abdomen. In such cases it may even be confused with an ovarian cyst. In my own case, as will be noted, the position beneath the left costal margin was so characteristic as to suggest the spleen at once, and this impression was strengthened by the X-ray picture.

The chief difficulty in diagnosis lies in the differentiation of these cysts from pancreatic cysts. The latter, however, usually occupy a lower position, even though they arise from the tail of the pancreas. Other points of differentiation, such as the history and the results of urinalysis, need not be elaborated upon here. Cysts and other tumors of the kidney can

Fig. 3. Section of cyst wall, showing dense fibrous wall, with lining of flattened, degenerated epithelium. The splenic tissue appears fairly normal.

usually be readily eliminated by proper urological examination.

TREATMENT

The ideal treatment is, of course, splenectomy, and this procedure, to judge from the published reports, is usually possible. In this respect splenic cysts differ from the pancreatic variety, which often present far greater technical obstacles to removal, necessitating marsupialization. The latter procedure today should be necessary only infrequently, though in the earlier days of splenic surgery it was resorted to more frequently. The same statement may be made as to simple incision and drainage, and also of aspiration, both of which methods have in the past been employed in some cases. Enucleation of the cyst has been done, but is rarely possible with any safety to the patient. Certainly it would seem a far more dangerous operation than splenectomy, and its justification is therefore questionable when splenectomy is feasible.

CASE REPORT

The patient was a married woman of 22, who was referred to me by Dr. R. L. Hoyt, of Baltimore. Her father had died of cancer of the stomach. Aside from the usual diseases of childhood, the past history did not seem significant. She had had frequent attacks of tonsillitis. No history of malaria or of trauma could be elicited. Menstruation had always been irregular, the intervals between periods being usually about 2 months, until 4 years ago when the function ceased entirely. She had been married 3 years, without pregnancies.

One year ago she noticed a lump in the left upper quadrant of the abdomen. It was at first painless, but as it increased in size, it caused some discomfort, with occasional sharp attacks of pain radiating to the left shoulder. These usually lasted about 15 minutes, and occurred at intervals averaging 2 or 3 weeks. The pain apparently bore no relation to the ingestion of food. More recently, when the tumor had become quite large, there had been some embarrassment of respiration, with a sensation of smothering. There were no gastro-intestinal or urinary symptoms.

In August, 1926 the patient had an attack of gastro-enteritis. In the routine examination made at that time Dr. Hoyt noticed the tumor, and advised surgical consultation, which, however was deferred until February 21, 1927.

February 27, 1927. The general condition of the patient was fairly good, although she was quite small and thin, with a rather gracile type of figure. The urinalysis was negative. The blood count showed red corpuscles 4,650,000, white cells 8,250, with a hæmoglobin of 80 per cent. No abnormalities of red cells were observed.

The abdomen presented a very striking picture. The lower portion was rather scaphoid, with thin abdominal wall and good muscle tone. Above the umbilicus, however, the contour differed on the two sides of the midline. The right side was relatively flat, but the left presented a distinct bulging due to the presence of a large mass which projected from beneath the left costal margin downward and inward to about the level of the umbilicus. It was apparently about the size of a child's head, and was slightly movable. It was definitely elastic in feel, suggesting a cyst. The stomach appeared to be displaced downward and to the right, as there was dullness and no tympany over the tumor mass. The mass was situated so far anteriorly that it appeared to be immediately beneath the abdominal wall, and it did not extend far back into the flank, so that it did not suggest a kidney origin. Furthermore, it was at a much higher level than a pancreatic cyst ordinarily is, even one arising from the tail of the pancreas. It gave the impression of something pushing downward and to the right from beneath the left side of the diaphragm.

X-ray examination showed the outline of the mass quite distinctly, and also a large rather atonic stomach displaced downward and to the right by the mass.

Urological examination revealed no abnormal findings in the left kidney region, so that a kidney origin could be eliminated.

Tentative diagnosis. Cyst of the spleen. The amenorrhœa was functional.

Operation. A longitudinal left rectus incision was made beginning at the ensiform cartilage and extending below the umbilicus. A huge liver-colored mass was found occupying the left upper quadrant. The stomach was pushed far downward and to the right, but presented no other abnormalities. The left lobe of the liver was in contact with the tumor. By passing the hand over it, the mass was found to fit snugly against the dome of the diaphragm on the left side. Below, it was covered with a mass of adherent omentum, with many rather large veins. There appeared, however, to be no adhesions to the diaphragm, so it was decided to attempt removal of the entire mass. At first it could not be delivered, but after the incision was lengthened to about 10 or 12 inches the hand could be passed beneath the large upper pole and the whole mass delivered extra-abdominally. This, of course, facilitated the removal a great deal. The upper part of the tumor was rounded, and presented a grayish yellow area where the cyst wall appeared without any covering of the splenic tissue. Over most of the remainder of the tumor there was a thin layer of splenic tissue, while at the lower pole there was a triangular mass of normal splenic tissue. This lower pole was covered by adherent omentum, but otherwise there were no adhesions. The gastrolienal ligament was carefully secured, the pedicle being very securely ligated. The splenic vessels were of course of very large size, and were secured with several heavy No. 3 chromic catgut ligatures. There was very little bleeding except in tying off the omental adhesions, which contained many fragile veins. On the whole, however, the operation presented no very great difficulty and it was possible to obtain perfect hæmostasis. After the tumor was removed a split was left which opened up the lesser sac of the peritoneum. For fear of intraperitoneal hernia this was securely closed. The abdomen was then closed without drainage.

The subsequent course was uneventful. There was a slight febrile reaction for a few days, but the incision healed perfectly. Daily blood counts were made, showing no peculiarities except a mild leucocytosis, the maximum being 12,200 white cells on the fourth day. On the day of discharge, 3 weeks after operation, the white cell count was 10,500.

Pathological report. The spleen, together with the cyst, formed a mass shaped somewhat like a football, though the upper pole was larger and more rounded than the lower. The entire mass measured 28 by 14 by 14 centimeters, and weighed 1,784 grams. The cyst proper on its external (diaphragmatic) surface was covered by a shell of attenuated splenic substance. At the upper pole this covering was absent, so that the cyst wall proper presented as a thickened grayish area. The lower pole was made up of a triangular peak of splenic tissue. The cyst occupied most of the inner or gastric surface of the spleen. Along one edge there was a ridge of splenic tissue, with a rather sharp margin (Fig. 1). Beyond this was the rounded cyst mass, with its rather thin semitranslucent walls. Between the splenic ridge and the cyst, near the lower third of the mass, could be seen the stump of the pedicle (Fig. 1).

The tumor was opened only after hardening. The contents of the cyst had evidently been a clear fluid, which had undergone coagulation and had become somewhat gelatinous. The inner surface of the cyst wall presented a remarkably trabeculated appearance, not unlike that seen with some multilocular cysts of the ovary (Fig. 2). There was, however, no suggestion of sacculation, the cyst forming one large compartment.

Microscopic examination. The cyst wall is seen to consist of a dense, fibrous, and in most places, hyalinized layer of connective tissue. Here and there it is covered by a single layer of low cuboidal epithelium, but in most places this epithelium is absent, presumably from pressure atrophy. There is no trace of hæmorrhage in the thinner parts of the cyst wall, but in the thicker parts a considerable amount of blood is seen between the layers of the cyst wall. This suggests that, in spite of the negative history, the cyst was probably of traumatic origin.

REFERENCES

1. Andral. Précis d'Anatomie Pathologique. Paris: 1829, 432.
2. Fowler. Ann. Surg., 1913, lvii, 660.
   Ann. Surg., 1921, lxxiv, 201.
   New York St. J. Med., 1922, xxii, 407.
   Ann. Surg., 1924, lxxx, 58.
3. Frank. Ann. Surg., 1927, lxxxv, 360.
4. Gambill. Kentucky M. J., 1923, xxi, 247.
5. Gosselin. J. Am. M. Ass., 1924, lxxxii, 849.
6. Howald. Frankfurt. Ztschr. f. Path., 1926, xxxviii, 349.
7. Pool and Stillman. Surgery of the Spleen. Surgical Monographs. New York: D. Appleton & Co., 1923.
8. Pribram. Monatschr. f. Geburtsh. u. Gynaek., 1922, lvii, 164.

PRIMARY STREPTOCOCCUS PERITONITIS IN CHILDREN[1]

By JOSEPH SCHWARTZ, M. D., New York
Junior Attending Surgeon and Assistant in Surgical Pathology, Lebanon Hospital

THE earlier writers recorded cases of primary infections of the peritoneum which, because of their obscure origin, were designated idiopathic spontaneous or rheumatic peritonitis. The condition was thought to be caused by colds and rheumatism. Grawitz, who disagreed with this point of view, exposed animals to sudden changes in temperature in an attempt to produce a peritoneal infection. The condition which we now recognize as streptococcus peritonitis, the older writers undoubtedly included in the category of idiopathic peritonitis.

This paper is based upon a study of 14 cases of streptococcus peritonitis—the most serious of acute abdominal lesions occurring in childhood and associated with an extremely high mortality.

Of our 14 patients 9 were females and 5 were males; all were fairly well nourished. Their ages ranged from 3 weeks to 13 years; only two were above 5 years of age. In an analysis (3) of 400 consecutive cases of surgical diseases in children 13 years of age and under, streptococcus peritonitis occurred in 1.5 per cent of the cases. In children 5 years and under of this series the incidence was 7 per cent. A seasonal influence was noted, as all the cases occurred between October and April except one which occurred during July. This parallels the corresponding seasonal occurrence of upper respiratory tract infections which bear considerable relation to the subject under discussion. The exciting agent was the streptococcus of the hæmolytic variety.

The mode of infection has not been definitely established but in searching for a possible focus of infection, we could not overlook the frequency of an upper respiratory tract lesion in the majority of cases. In 10 there was present a nasopharyngitis, marked in some, while in others the acute stage had already subsided at the time of admission. In about one-half of these, a throat smear revealed the streptococcus to predominate. A pure culture of streptococcus was unobtainable after the patient entered the hospital because more than one organism was already present. In two of the cases there was a purulent otitis media the exudate of which yielded a pure culture of streptococcus hæmolyticus. It is my opinion that the organism entered the circulation at some point in the pharynx, possibly through the tonsils, and then produced a transient bacteriæmia with localization in the peritoneal cavity. It is common knowledge that the peritoneum by means of its normal defensive mechanism is capable of destroying innocuous material and a certain dosage of bacteria, but the virulence of the streptococcus hæmolyticus is ordinarily so great that in children with diminished resistance any protective tendency is easily overcome. Blood cultures were taken in 4 cases and found positive in two. If blood cultures were taken early in the disease and repeated frequently, it is likely that the percentage of positive findings would be considerably higher.

In a series of 22 cases of pneumococcus and streptococcus peritonitis reported by Lipshutz and Lowenburg (10), there was a history of a preceding throat infection in 90 per cent of the cases. Rabinowitz (13) cites a similar experience in 8 cases of streptococcus peritonitis. In a severe epidemic of streptococcus sore throat Chapelle (2) has studied 18 cases of streptococcus peritonitis. Hamburger (7) found 12 cases in a Baltimore epidemic. Davis and Rosenow (4) found 4 cases in another epidemic. In several other epidemics of sore throat of lesser severity, streptococcus peritonitis is mentioned as a complication. The association of this type of peritonitis with a sore throat appears to be rather common.

In two of the cases of this series, the genital tract suggested itself as the portal of entry. There was a marked vulvovaginitis with swelling and redness of the labia; a discharge was present. Smears showed a mixed infection with cocci in excess. The avenue of infection

[1] Read before the Bronx County Medical Society, New York, March 16, 1927.

was probably along the vagina, uterus, and fallopian tubes. The presence of an exudate in the tubes at the time of operation supported this view. Armstrong (1) reported 5 cases of peritonitis in female children in two of which it was caused by the streptococcus. He suggested the genital tract as the avenue of entrance. In a study of a large series of cases of primary pneumococcus peritonitis in children, McCartney and Fraser (11) found the disease to occur in females exclusively. They have advanced some evidence in support of their view of the genital transmission of the infection.

Streptococci along with other pathogenic organisms, have been recovered from the intestinal tract, and in view of this it has been suggested that the organisms pass through the intestinal wall and produce a peritonitis. In only one of our cases was the peritonitis secondary to an inflammatory lesion which was confined to the cæcum and was in the nature of a typhilitis. The probable sequence of events in this case was first a pharyngitis followed by septic material invading the blood stream, then a localization in the ileocæcal region and ultimately a peritonitis. Streptococci were obtained from the surface of the cæcum. A localized purulent peritoneal exudate appeared a few days after the operation, as was evidenced from an enormous discharge through the abdominal incision. Streptococci were obtained from the exudate. Some observers are of the opinion that bacteria will pass through the intestinal wall only if a pathological condition exists. Lennander (9) and others report cases of streptococcus peritonitis in which they found ulcers in the stomach, intestine, and appendix. Jensen (8), who favored the gastro-intestinal mode of infection, fed animals with virulent pneumococci but failed to produce a peritonitis except in one animal. Others repeated these experiments without success. In the cases of this series which came to autopsy a search failed to reveal any gastro-intestinal lesion.

Transmission of organisms to the peritoneum by way of the lymph stream as has been suggested did not seem justifiable in a single case. In two children, no demonstrable focus could be found to account for the peritoneal infection. It is possible that a throat infection was present but had escaped the parents' attention.

SYMPTOMS

The initial phase manifests itself in a nasopharyngitis with a slight cough and a temperature ranging between 100 and 102 degrees F. The parents frequently volunteer the information that all the child has had is a cold. The abdominal symptoms generally appear rather abruptly several days after the onset of the initial phase while the child is apparently recovering from the upper respiratory tract infection. There is a sudden rise in the temperature up to 104 to 106 degrees F. with vomiting, which is repeated later in the course of the disease. Older children complain of cramps. Some parents inform us that the child's abdomen was hard, implying thereby that some rigidity was present. Diarrhœa was notably absent in all but 3 cases. The physical signs are usually slight and in fact entirely out of proportion to the severity of this grave condition. Abdominal pain is elicited early in most of the cases; it is diffuse but more marked in the lower abdomen. Rigidity is absent in the cases seen early. It is present later but is not very marked in most of the cases. Distention was moderate in 5 cases and pronounced in one. It was never troublesome even up to the time of death. The constitutional symptoms are very severe and progressive, indicative of a profound toxæmia. The temperature varies between 104 and 106 degrees F. The pulse and respiration are very rapid. The blood shows an average white cell count of 32,000 with an average differential of 90 per cent polymorphonuclears and 10 per cent lymphocytes. The pharynx and tonsils still exhibit signs of a recent infection in the majority of cases, marked in some. Sordes was common. The cervical glands were very much enlarged in one case. In two cases the nervous manifestations were so pronounced as to make it necessary to do a lumbar tap in order to exclude a diagnosis of cerebrospinal disease. In three cases the urine was indicative of renal disturbance.

The disease is rapidly progressive up to the time of death which usually occurs in 1 to 4 days after the operation. Prostration is

marked. Of the three patients that recovered two had a stormy convalescence; their stay at the hospital was 6 weeks each. The third the youngest of the three, remained at the hospital 26 days; her convalescence being uneventful.

PATHOLOGY

In the patients operated upon early, there was seen a small amount of serous slimy, sticky exudate with fibrin flakes covering the intestinal coils in some of the cases. The peritoneum was diffusely injected and in many the seat of small punctate hæmorrhages. The intestines were highly injected and moderately distended. In the advanced cases the exudate was considerably increased and seropurulent or fibrinopurulent in character. The coils of intestine were lightly adherent; distention was more pronounced but not excessive. In none of the cases was there an attempt at localization noted. The appendix was inspected in every case but one and was found to have its peritoneal coat involved as part of the generalized peritonitis. In four cases it was removed at the time of operation and in 3 of these, microscopic examination revealed only a subserous inflammation secondary to the general peritonitis. The other appendix showed an infiltration in all coats with a moderate number of polynuclear leucocytes; this was the result of a lesion in the ileocæcal region. The mesenteric glands were found enlarged in many of the cases. The peritoneal exudate yielded streptococcus hæmolyticus in pure culture in every case but one; in the latter the non-hæmolytic organism was found.

It cannot be too strongly emphasized that a complete and careful bacteriological examination of the exudate is essential in order to avoid confusion between the streptococcus and pneumococcus peritonitis. On several occasions we considered the lesion at the time of operation to be caused by the pneumococcus until a contrary report by the laboratory was received. Rischbeth (14) reported 54 cases of pneumococcus peritonitis but only half of them were proved bacteriologically. He designated the other cases to be of similar bacterial origin because of the striking resemblance of the exudate to that found in the other cases which were proved to be of pneumococcus origin. In our series the character of the exudate at the time of operation and subsequently gave insufficient evidence on which to base a bacteriological diagnosis. Fishbein (5) has shown, from postmortem study of a large series of cases of peritonitis, that one cannot determine from the nature of the exudate the type of organism responsible without bacteriological investigation.

The cases which came to autopsy show the lesions described previously in a much more advanced stage. The exudate which now is more fibrinous, is spread diffusely throughout the peritoneal cavity, under the diaphragm and over the surface of the liver and spleen. The pelvis contains the greater part of this plastic exudate. This finding should not be interpreted as evidence favoring the genital origin of infection in all female children. Even at this late stage there is no attempt at localization of the infection. The internal organs are the seat of a marked parenchymatous degeneration, the result of a profound toxæmia. The spleen was very soft in two cases, indicating the possible existence of a grave blood stream infection. The gastro-intestinal tract was carefully examined for any gross lesion which might have permitted the passage of infectious material into the abdominal cavity, but none was found. The mesenteric glands, which were moderately enlarged in every case, did not suppurate. This latter is a very common postmortem finding in children regardless of the cause of death, so no significance was attached to it.

DIAGNOSIS

Streptococcus peritonitis presents difficulties which make it almost impossible of accurate clinical recognition. Careful watch of the abdomen is of the utmost importance in a child convalescing from a naso-pharyngitis, who suddenly has a rise in temperature and develops signs and symptoms suggestive of a peritoneal irritation. Only by bearing in mind that a complication such as streptococcus peritonitis is likely to occur, will one be able to detect the earliest manifestations.

The most frequent condition for which this disease was mistaken was acute appendicitis.

It was thought to exist in the majority of our cases. In appendicitis the onset is not so severe, the temperature much lower, the constitutional symptoms are milder, and the blood count is not so high. The abdominal signs are localized more to the right lower region; rigidity is more pronounced. On rectal examination a tender mass may be palpable.

A clinical differentiation between streptococcus and pneumococcus peritonitis is almost impossible. If a pneumonia or a pneumococcus otitis media or pneumococcus vaginitis exists, one may incline toward a diagnosis of pneumococcus peritonitis. In the latter the clinical course is milder; there is a doughy feel to the abdomen, and diarrhœa is present in a large number of cases. Because of the similarity of the clinical manifestations of these two types of peritonitis, a differential diagnosis can rarely be made. As stated before, even after the abdomen is open, no characteristic pathological changes are found which will identify either one without bacterial analysis.

Pneumonia was considered a possible diagnosis in some cases because of the presence of suspicious chest signs in children who had a rise in temperature after an upper respiratory tract infection. This view was strengthened in the absence of abdominal signs necessary for an early diagnosis of streptococcus peritonitis.

Not infrequently, lesions in the chest are the cause of referred abdominal symptoms and such early abdominal manifestations as occurred in this group were interpreted as reflex. Only after the peritoneal phase became more apparent and the X-ray excluded a diagnosis of pneumonia, was our attention focused on the abdominal infection.

In two cases, a lumbar tap was necessary to exclude a diagnosis of cerebrospinal disease.

In spite of points of clinical difference in the above-mentioned diseases, clinical variations in symptoms may be insufficient for an accurate diagnosis. The only means at our disposal then for establishing a positive diagnosis prior to operation is a peritoneal puncture. This was employed in 5 of these cases; the exudate which was aspirated was positive for streptococci in every case. The method is very simple and practically free from danger if done with a suitable instrument. In each of the 22 cases of peritonitis reported by Lipshutz and Lowenburg a puncture was done without any complications. Neuhof and Cohen (12) have employed this diagnostic procedure in over 100 cases of wide variety without any injury to the abdominal viscera. A favorite site for puncture is the midline below the umbilicus and well above the bladder. To avoid injuring the latter it should be empty. The skin and fascia are infiltrated with a few drops of 1 per cent novocain to allay any unnecessary pain. With a bistoury, a punctured wound is made through the skin and fascia to facilitate the entrance of the blunt needle into the peritoneal cavity. The direction of the needle should be toward the pelvis. With a 5 cubic centimeter syringe attached to the needle we aspirate very slowly, changing the direction of the needle very carefully if necessary. It is important to remember that in the early stage the exudate is scant and that later on it becomes more fibrinous; therefore one should not expect to obtain more than two or three drops of exudate. This amount is sufficient for a direct smear for our immediate information as to the type of organism. A culture should always be made at the same time as in the event of refusal for operation or if the patient expires without surgical intervention a complete bacterial study and classification will have been accomplished.

We do not recommend a peritoneal puncture as a routine procedure but its application is urgently advised as a valuable diagnostic measure in the more obscure cases. Its prognostic value can be appreciated if one remembers that it offers the surgeon the advantage of accurate knowledge of the existing lesion prior to operation and that in the light of such facts he can almost with certainty foretell the outcome.

A pure culture of streptococci obtained from the aspirated pus prior to operation is indicative of a grave lesion and should lead one to give a decidedly grave prognosis. If colon bacilli are obtained, the underlying lesion will most probably be acute appendicitis—a condition of lesser severity and more hopeful outlook. A negative puncture must not be regarded as indicating the absence of a bacterial invasion of the peritoneum, as the exudate

may be so thick or fibrinous that it may not pass through the needle.

PROGNOSIS AND TREATMENT

There is still some diversity of opinion as to the management of streptococcus peritonitis. Some advocate early surgical intervention while others in view of the high mortality after operation defer peritoneal drainage until localization takes place. All of our 14 cases were operated upon as soon as the diagnosis was made except in one case. Here a waiting policy was adopted but the child's condition became so desperate that immediate drainage was thought to be the only chance for the child; the outcome was fatal. The average time between the initial infection in the upper respiratory tract and operation was 9 days. Early drainage seems to be the rational therapy since waiting augments the spread of infection without any tendency toward localization. Delay reduces that slight chance for recovery which is favored by early surgical intervention. One is not justified in waiting in a case of streptococcus peritonitis not definitely proved, as an acute appendicitis may be overlooked. Supportive treatment should be instituted soon after the patient is seen. Fluids should be forced by every available channel to combat the profound toxæmia. Transfusions are likely to prove of considerable value in some cases.

No other acute abdominal lesion in childhood is attended by such high mortality. Of this series, 3 recovered; a mortality of 79 per cent. Other statistics show a mortality between 80 to 100 per cent. There was a higher percentage of recovery among older children.

In our series the three children who survived the infection were 13, 11, and 4 years old. I have found no instance in which a patient with proved streptococcus peritonitis recovered without operation.

SUMMARY

The occurrence of 14 cases of primary streptococcus peritonitis in a comparatively short period shows it is not a rare disease. In children 5 years and under it constitutes 7 per cent of all surgical diseases.

In view of the fact that in 10 of these cases there was the initial infection affecting the upper respiratory tract, it is fair to assume that the peritoneal infection came by way of the blood stream. Vulvovaginitis, by direct extension along the genital tract, was responsible in two cases. Other modes of infection did not suggest themselves in this series.

The symptoms were those of peritoneal irritation, namely, pain, vomiting, abdominal tenderness and rigidity, together with high temperature, high white cell count, and prostration.

An early exact diagnosis is difficult because the symptoms and signs are often slight and not significant of the disease.

Acute appendicitis is most often confused with streptococcus peritonitis and the only positive method for a correct diagnosis is a peritoneal puncture.

The treatment is surgical as soon as the diagnosis is established; supportive therapy must be instituted early. The prognosis is very high, 79 per cent in our series; older children are favored with a slightly better chance for recovery.

For the courtesy of permission to report these cases I am indebted to Drs. Henry Roth and L. Miller Kahn. I also wish to thank Drs. Milton Bookman and Louis Sheinman for the privilege of including two private cases.

BIBLIOGRAPHY

1. Armstrong. Montreal M. J., 1903, xxxii, 773.
2. Chapelle. Arb. a. d. Path. Instit. d. Univ. Helsingfors, 1907, ii, 583.
3. Cohen, Morris. Surg., Gynec. & Obst., 1927, xlv, 595.
4. Davis, D. J., and Rosenow, E. C. J. Am. M. Ass., 1912, lviii, 773.
5. Fishbein, M. Am. J. M. Sc., 1912, cxliv, 502.
6. Grawitz. Charité Ann., 1884, xi, 770.
7. Hamburger, L. P. J. Am. M. Ass., 1912, lviii, 1109.
8. Jensen. Arch. klin. Chir., 69–70, 1903, lxix–lxx, 1134.
9. Lennander. Deutsche Ztschr. f. Chir., 1902, lxiii, 1.
10. Lipshutz and Lowenburg. J. Am. M. Ass., 1926, lxxxvi, 99–104.
11. McCartney, J. E., and Fraser, J. Brit. J. Surg., 1922, ix, 479.
12. Neuhof, H., and Cohen, I. Ann. Surg., 1926, lxxxiii, 454.
13. Rabinowitz, M. A. Am. J. M. Sc., 1919, clvii, 797.
14. Rischbeth. Quat. J. Med., 1903, xxxii, 728.

ACUTE SURGICAL DISEASES OF THE ABDOMEN IN CHILDREN

A Study of Four Hundred Cases[1]

By MORRIS COHEN, B.S., M.D., New York
Adjunct Attending Surgeon, Lebanon Hospital

THE patients we see in our daily practice leave impressions that may be transient or lasting and the sum total of these impressions constitutes our experience which is the basis of the opinions we hold concerning the various diseases we encounter. Perhaps a careful study of one's experience in a particular field of surgical practice may result in the breaking down of some views, in the reinforcement of others, or perhaps in the creation of entirely new opinions. It is with this thought in mind that I have attempted to review the subject of acute abdominal diseases in children basing this study upon personal observations made primarily in the wards and operating rooms of Lebanon Hospital and upon the records of 400 patients admitted consecutively to Lebanon Hospital over a period of 4½ years beginning January 1, 1922.

In this discussion the term child refers to a patient who is 13 years of age or under. "Acute abdominal disease" refers to any acute disturbance in a child's abdomen, which is not the result of trauma and which requires surgical treatment.

GENERAL CONSIDERATIONS

When we read the list of pathological conditions encountered we find that they can be classified into two large groups. The first, and by far the larger of the two, includes all those pathological conditions that are primarily inflammatory in character, and the second group includes all those conditions the pathology of which is due to some mechanical derangement of normal relations.

Examination of the records of the patients in the first group reveals that out of 367 patients who at the time of admission to the hospital were apparently suffering from some acute, inflammatory intra-abdominal disease, 354 were admitted with the diagnosis of acute appendicitis. In one of the latter number, typhoid fever was the admission diagnosis, but this was changed to acute appendicitis after the patient had been in the hospital one day. All of these 354 children were not subjected to operation. Out of 327 children operated upon for acute appendicitis, varying degrees of inflammatory change of the appendix were found in 312. Operation or subsequent findings revealed the following conditions in the remaining 15 children: pyelitis in 3; mesenteric lymphadenitis in 6; and in 1 of these the tip of the appendix was buried in a suppurating mesenteric node; primary acute diffuse peritonitis in 3; torsion of an ovarian cyst pedicle in 1; and torsion of the omentum in another. The last two conditions, wrongly diagnosed as acute appendicitis, can be properly included in the group of cases discussed as mechanical derangements. One child, whose peritoneal cavity contained a large quantity of serous fluid which proved to be sterile, was released from the hospital one week after operation while he was still running an irregular, febrile temperature. The diagnosis in this instance was not determined.

The 27 children who were not operated on were discharged from the hospital cured or improved. The final diagnoses for these patients were gastro-enteritis, colitis, and constipation in 7, pyelitis in 2, chronic appendicitis in 6, acute salpingitis in 1, ascaris lumbricoides in 1, nasopharyngitis in 1, influenza in 1, and undiagnosed, 8.

The remaining diseases in the inflammatory group were as follows: primary peritonitis due to the streptococcus or pneumococcus occurred in 10 children 3 of whom were operated upon for acute appendicitis, while acute cholecystitis, nephrolithiasis, secondary abscess after appendectomy, perirenal abscess and liver abscess were represented by one patient each. One child, a boy of twelve, who showed signs of diffuse peritonitis died immediately after admission to the hospital and the

[1] From the Surgical Services of Lebanon Hospital. Read before the Bronx County Surgical Society, February 23, 1927.

TABLE I.—ANALYSIS OF FOUR HUNDRED CASES STUDIED

I. Patients admitted for acute inflammatory intra-abdominal conditions	367
A. Admitted with diagnosis of acute appendicitis	354
Operated upon for acute appendicitis	327
Appendicitis found in	312
Other conditions found	
Pyelitis	3
Lymphadenitis	6
Primary peritonitis	3
Twisted ovarian cyst pedicle*	1
Torsion of omentum*	1
Undiagnosed	1
Not operated upon	27
Gastro-enteritis, colitis, constipation	7
Pyelitis	2
Chronic appendicitis	6
Acute salpingitis	1
Ascaris lumbricoides in intestines	1
Nasopharyngitis	1
Influenza	1
Undiagnosed	8
B. Miscellaneous	13
Primary peritonitis	7
Perirenal abscess	1
Subphrenic and liver abscess	1
Acute cholecystitis	1
Nephrolithiasis	1
Secondary peritoneal abscess	1
Peritonitis (died on admission)	1
II. Patients with mechanical derangements	35
A. Intestinal obstruction	33
Intussusception	22
Incarcerated hernias	7
Miscellaneous	4
Atresia of the colon	1
Volvulus of sigmoid	1
Obstruction due to band	1
Obstruction (transient)	1
B. Miscellaneous	2
Torsion of ovarian cyst pedicle*	1
Torsion of omentum*	1

*Included under Headings I and II.

cause of the peritonitis was therefore not determined although it was undoubtedly of appendicular origin.

ACUTE APPENDICITIS

Age distribution and etiology. As acute appendicitis is represented by the largest number of patients, a detailed study of this condition will be made. Among 312 patients in whom appendicitis was found, 194 were boys and 118 were girls. The youngest child was 1 year old and was the only patient at that age. The greatest number of cases for any single year occurred at age 10 (Table II). As age increases, the frequency with which appendicitis occurs also increases. That

TABLE II.—CASES OF ACUTE APPENDICITIS ACCORDING TO AGE

Age in years	Number of cases	Age in years	Number of cases
1	1	8	32
2	8	9	27
3	18	10	43
4	15	11	30
5	17	12	42
6	19	13	32
7	28	Total	312

TABLE III.—CASES OF ACUTE APPENDICITIS ACCORDING TO SEX

Sex	Number
Male	194
Female	118
Total	312

acute appendicitis is not an uncommon ailment in the very young is proved by the presence of 59 cases in children 5 years of age or under. To explain the increasing incidence of the disease as the child grows older is a matter of speculation. Fraser's explanation based on anatomical and bacteriological principles is deserving of consideration.[1] He suggests that the increasing amount of lymphoid tissue in the appendix as the child grows older renders that organ more susceptible to infection by the bacillus coli which is most frequently found in acute appendicitis. The toxicity of the bacillus coli is enhanced by a varied diet and occasional attacks of gastro-enteritis. Other causes at all ages are foreign bodies, the most frequent one being the fæcolith and in one instance pinworms, kinks and twists of the appendix, constipation and intestinal infections from carious teeth, tonsillitis and infections of the upper respiratory tract. In 8.6 per cent of the cases in this series there was a coincident tonsillitis or nasopharyngitis. In addition to these, two children had just recovered from scarlet fever, two had pneumonia, one measles, and one whooping cough.

Pathology. Microscopic examination of the appendices shows that the infection begins in the mucous coat, then involves the submucous lymphoid tissue and from there travels outward through the muscular layer to the peritoneum. Where there is destruction of tissue, this disintegration begins in the mucous

[1] Fraser. Surgery of Childhood. Edinburgh: 1926, ii, 823.

lining of the appendix and the process progresses slowly or rapidly to localized or general gangrene and perforation, with the complicating abscess or peritonitis. The thinness of the appendicular wall and the large amount of lymphoid tissue explain perhaps the rapid and virulent course that appendicitis takes so often in the very young. The bacillus coli as already stated above, was the infecting organism most frequently isolated.

Symptoms. The classical syndrome of abdominal pain which localizes in the right lower quadrant and which is followed by vomiting predominated in this series. Seventy-five per cent of the patients gave such a history. In 15 per cent there was no vomiting, in 6 per cent vomiting preceded the pain and in the remaining cases there was no record of vomiting. A few patients complained of pain in the right upper or left lower quadrant. Most children were constipated or had regular bowel movements. Diarrhœa was exceptional. Convulsions occurred in two children and chills were unusual. In one child who died progressive jaundice was an outstanding symptom and indicated a virulent infection with an early complicating pylephlebitis. Although every rule has its exceptions, and this is well illustrated here, I cannot emphasize too strongly in the diagnosis of acute appendicitis in children the importance of adhering closely to the classical group of symptoms—abdominal pain, pain which localizes in the right lower quadrant, and vomiting. When there is any deviation from the usual sequence of these symptoms, one should look for unquestionable physical signs for only positive evidence should lead us to operate for acute appendicitis.

Physical signs. Tenderness and rigidity of varying degree in the right lower quadrant were the outstanding physical signs. In some instances where a localized abscess was found, a mass could be felt in the right lower quadrant and in isolated instances a mass could be felt by rectal examination. Tenderness to the left of the midline was noted in a few patients and in these the tip of the inflamed appendix was found on that side. In two children in whom the tenderness and rigidity seemed to be most marked in the right upper quadrant of the abdomen, the tip of the inflamed appendix was found in contact with the lower pole of the right kidney in one and high up under the liver in the other.

Temperature, pulse and respiration. The degree of elevation of temperature was not found to be always consistent with the amount of pathological change found. Fever varied from a rise of less than one degree in some instances to one of five or six degrees in others. A few children had a normal temperature when admitted to the hospital. However, in most of these children the temperature on admission varied between 100 degrees F. to 102 degrees F.

The pulse rate usually varied from 100 to 120 per minute. When the pulse rate was very rapid, there was a local or spreading peritonitis.

Respirations were not increased to any appreciable degree. When the respirations are markedly rapid, the chest should be carefully examined for signs of pneumonia. On several occasions I have seen children with symptoms of acute appendicitis, in whom physical examination revealed the presence of a developing pneumonia.

Blood count. In these cases of acute appendicitis, we found an increase in the total number of leucocytes, the average number found in uncomplicated cases being 14,000 per cubic millimeter, and a relative increase in the polymorphonuclear leucocytes, the average percentage being 80. When peritonitis had ensued, both total number of leucocytes and percentage of polymorphonuclear cells were much higher. Deviations from this rule and the presence of an increased white cell count in so many other conditions have caused me not to look upon the blood count as deciding evidence for a diagnosis of acute appendicitis.

Urine examination. The results of the chemical and microscopic examinations of the urine in these patients at the time of admission to the hospital warrant the conclusion that in acute appendicitis the urine remains unchanged. Three children who were operated upon for acute appendicitis and whose urine showed albumin and clumps of pus cells were actually suffering from acute pyelitis. Two other patients admitted to the hospital for acute appendicitis were not operated upon

because examination of specimens of their urine revealed similar findings and a diagnosis of acute pyelitis was made in each case. These five children recovered after proper medical treatment was instituted.

Evaluating the factors that determine the diagnosis of acute appendicitis in a child, history and abdominal physical signs are the most important. Nothing taxes the patience of the physician more than the eliciting of these physical signs in a child. This applies particularly to the very young. The abdomen of the crying child is held rigid voluntarily, yet if the examining hand is applied lightly and held in position persistently there will be intervals when this voluntary spasm disappears and the relaxed abdominal wall of the normal abdomen is felt, or when localized rigidity is present relatively softer areas in other parts of the abdomen become apparent. I have noticed general abdominal rigidity in young children when there was only an uncomplicated acute appendicitis. The eliciting of tenderness presents similar difficulties. An increase in the intensity of the child's cry while the abdomen is being palpated is usually indicative of tenderness, and as Dr. Henry Roth has demonstrated a persistent attempt on the part of the child to push away the examiner's hand, a protective mechanism, is usually indicative of an intra-abdominal inflammatory condition; however, when the child does not object to the examining hand, we can safely assume the absence of an acute inflammatory condition.

Factors influencing course of appendicitis. The ultimate outcome of acute appendicitis in a child is definitely influenced by age, duration of illness prior to operation, the administration of cathartics and by the occurrence of previous attacks.

Effect of age. That in children in the first 4 years of life acute appendicitis runs a rapid and frequently fatal course is evidenced by the fact that among 42 children 4 years of age and under there were 8 deaths, a mortality of 19 per cent, while for the entire group there were 13 deaths, a mortality of only 4 per cent.

Effect of duration of illness. Drainage of the abdominal cavity was instituted whenever the appendix was perforated or when there was a complicating abscess or peritonitis. Examination of Table IV shows that as the duration of illness prior to operation increases there is a definite increase in the number of cases that had to be drained. Drainage was employed in 48 per cent of the patients who were ill only one day while it was used in 85 per cent of those children who were sick 7 days. There is a drop in the percentage of cases drained when illness lasted for a period longer than one week. In these few children, the inflammatory process was subsiding at the time of operation.

TABLE IV.—EFFECT OF DURATION OF ILLNESS ON COURSE OF ACUTE APPENDICITIS

Duration in days	Cases	Drained	Per cent drained
1	149	73	48
2	77	49	63
3	30	20	66
4	20	12	60
5	6	4	66
6	9	7	77
7	7	6	85
8 or more	12	7	58
No record	2	1	50
Total	312	179	57

Effect of catharsis. Table V shows the effect of catharsis upon the course of acute appendicitis in children. Out of 64 patients who received catharsis before operation 71 per cent were drained, while out of 38 children who did not receive such treatment only 42 per cent were drained. That catharsis during an attack of acute appendicitis has a deleterious effect upon the course of the disease seems to be established.

Effect of previous attacks. Table VI shows that children who have had one or more previous attacks of acute appendicitis seem to have a milder form of the disease in subsequent attacks. Out of 65 patients who have had earlier attacks of acute appendicitis only 49 per cent were drained while out of 140 who did not have any such previous illness 61 per cent were drained. These unexpected figures are readily explained by the fact that in these patients, fibrosis of the appendix and adhesions limit the extension of the inflammatory process, or, by what seems more likely, that parents send their children to the hospital much earlier in subsequent attacks of acute

TABLE V.—EFFECT OF CATHARSIS PRIOR TO OPERATION ON COURSE OF ACUTE APPENDICITIS

Catharsis	Cases	Drained	Per cent drained
Yes	64	46	71
No	38	16	42
No record	210	117	55
Total	312	179	57

TABLE VI.—EFFECT OF PREVIOUS ATTACKS ON COURSE OF ACUTE APPENDICITIS

Previous attacks	Cases	Drained	Per cent drained
Yes	65	32	49
No	140	86	61
No record	107	61	57
Total	312	179	57

TABLE VII.—DEATHS FROM ACUTE APPENDICITIS ACCORDING TO AGE

Age in years	Cases	Deaths	Per cent mortality
1	1	..	..
2	8	5	62.5
3	18	2	11.1
4	15	1	6.6
5	17	..	..
6	19	..	..
7	28	..	..
8	32	..	..
9	27	1	3.7
10	43	1	2.3
11	30	3	10.0
12	42	..	..
13	32	..	..
Total	312	13	4.1

TABLE VIII.—DEATHS FROM ACUTE APPENDICITIS ACCORDING TO DURATION OF ILLNESS PRIOR TO OPERATION

Duration of illness in days	Cases	Deaths	Per cent mortality
1	149	1	0.6
2	77	3	2.5
3	30	1	3.3
4	20	..	..
5	6	1	16.6
6	9	4	44.4
7	7	2	28.5
8 or more	12	1	8.3
No record	2	..	..
Total	312	13	4.1

appendicitis. Out of 65 children who have had previous attacks of acute appendicitis 62 per cent came to operation during the first day of illness, while out of the 140 children who were having their first attack of acute appendicitis only 50 per cent were operated upon during the first day of illness.

Deaths from acute appendicitis. In this series of 312 cases of acute appendicitis there were 13 deaths, a mortality of 4 per cent. Two of these children had pneumonia when admitted to the hospital, another child had a severe form of chronic cardiovalvular disease, one child when admitted had a nasopharyngitis, bilateral otitis media and stomatitis, while still another had a fulminating type of acute appendicitis in which there was a complicating pylephlebitis before operation. The greatest mortality for any single age occurred at age 2 when 5 out of 8 children died giving a mortality of 62 per cent. The children at age 3 had a mortality of 11 per cent and those at age 11 a mortality of 10 per cent. As already stated the mortality among the patients 4 years of age and under was 19 per cent, while for the entire group of 312 patients it was only 4 per cent. This percentage would have been much lower had there not been other serious complicating diseases in 5 of the children who died. The danger of postponing operation is well illustrated by these 13 deaths, 5 of which were of children who had been ill from 1 to 3 days, while 8 were of children who had been sick from 5 days to more than a week.

This analysis of a group of 312 cases of acute appendicitis in children shows that this condition is the most frequent abdominal disease in children requiring surgical treatment; that younger children are more likely to have a serious form of the disease; that delaying operation means inviting complications and death; that catharsis is undoubtedly a cause of complications in many patients; that previous attacks of acute appendicitis for reasons explained above do not predispose the patients to serious complications in the attacks for which they are operated upon; that blood count, temperature, pulse, and respirations are of secondary importance in the diagnosis of this disease; that urinary findings are negative in most cases of acute appendicitis; that history and abdominal physical signs should be the guiding factors in arriving at a diagnosis; and what is very important that patience on the part of the examiner is an important attribute when studying a child who has symptoms of acute abdominal disease.

Differential diagnosis of acute appendicitis. In the differential diagnosis of acute appendicitis, it appears from a study of the diseases found in this series, that mesenteric lymphadenitis and acute pyelitis are the only conditions wrongly diagnosed as acute appendicitis that need more lengthy discussion than mere mention of their names.

Mesenteric lymphadenitis. The symptoms and physical signs of mesenteric lymphadenitis are so often like those of acute appendicitis that a correct diagnosis is rarely made. Abdominal examination usually does not reveal any palpable nodes. If these children come to operation because of a diagnosis of acute appendicitis, the enlarged lymph nodes usually found in the ileocæcal region should be left alone unless suppuration has occurred. There may be enlarged nodes in other parts of the abdomen. These children generally recover completely without any other treatment except the employment of general hygienic measures. Although inflamed mesenteric nodes accompany the inflammatory intestinal diseases and are found as part of glandular fever in children, they are most often due to a primary tuberculosis of the mesenteric lymph nodes and should be treated accordingly.

Pyelitis. Five children, four of whom were girls, had pyelitis and they were all admitted with the diagnosis of acute appendicitis. They were 5 years of age and older. The symptoms of acute pyelitis vary in intensity and at times are so slight that a correct diagnosis can be made only after urine examination. In the older children, as found in this group, there may be local symptoms in addition to the general constitutional symptoms, and the former may predominate. The local symptoms often experienced are abdominal pain, pain in the flank, and painful micturition. When these are accompanied by tenderness and rigidity on the right side of the abdomen a diagnosis of acute appendicitis is often made. Urinary findings determine the correct diagnosis. In this series, none of the children with acute appendicitis had clumps of pus cells in the urine. Such findings especially in a female child admitted to the hospital for acute appendicitis should warrant the withholding of surgical interference until the correct diagnosis is definitely established.

PRIMARY PERITONITIS

There remains to be considered among the inflammatory diseases the cases of primary peritonitis which are a source of great concern to the surgeon. The 10 cases in this group consisted of 5 that were caused by the streptococcus hæmolyticus, one by the streptococcus non-hæmolyticus, 3 by the pneumococci, and one in which the causative organism was not determined. Five of the 6 children who were suffering from streptococcus peritonitis were 5 years old or younger, and 1, the only one to survive, was 13 years old. Four were girls and 2 were boys, and in one of the former the fallopian tubes were discharging pus. All of these children had infections of the respiratory tract prior to the onset of abdominal symptoms. One child had abdominal symptoms for a week prior to operation while in the remaining 5 the duration of symptoms was not longer than 2 days.

One child, a girl of 8, in whom the infecting organism was not determined, recovered.

All of the children with pneumococcus peritonitis were girls, 2 of whom were 6 years old and 1 was 4 years old. The duration of abdominal symptoms in all of these children was one day and only one patient gave a history of a preceding respiratory tract infection. In this child the right fallopian tube was found to be œdematous. The mortality for pneumococcus peritonitis was 100 per cent.

Primary peritonitis does not present so much a problem of diagnosis as of treatment. All of the patients in this group were operated upon and 8 of 10 died. Some workers have advised waiting until the peritonitis localizes, others operating immediately after the diagnosis is made. It seems that these children have a very high mortality no matter what course is taken. However, as we are never certain that acute appendicitis is not the cause of an existing peritonitis, a rapid diagnostic laparotomy is always indicated.

MECHANICAL DERANGEMENTS

In the group of patients whose symptoms were due to mechanical disturbances there

were 35, and among these are included the two children whose conditions were wrongly diagnosed as acute appendicitis but who were found to be suffering from torsion of the omentum and torsion of an ovarian cyst pedicle, respectively. In the light of the operative findings in the first of these patients it is seen that the abdominal physical signs, tenderness at and to the left of the umbilicus were suggestive of the pathological condition found. As for torsion of uterine adnexa in children, I have shown in an earlier paper that when signs and symptoms pointed to a lesion in the lower abdomen, particularly on the right side, there was a tendency to diagnose the condition as appendicitis.[1] Twenty-two of the children had acute intussusception, seven incarcerated hernias, two had intestinal obstruction produced by congenital anomalies of the gastro-intestinal tract, one boy of 13 was found to have intestinal obstruction produced by a band that bound down the distal end of the ileum, and one child who had been operated upon 7 months previously came in with a transient attack of intestinal obstruction that disappeared spontaneously. The diagnosis of incarcerated hernia was not difficult to make for in all of the children who had this condition there was the history that the child had had a reducible hernia that suddenly became painful and irreducible. The presence of a tender irreducible mass in the inguinal region confirmed the diagnosis. Two children, both females, began to show signs of intestinal obstruction soon after birth and at the time of operation they were 2 and 4 days old respectively. The younger child had a volvulus of the sigmoid produced by a cyst that was suspended from the sigmoid by a long pedicle. This pedicle was not alone twisted but it was wound around a loop of the sigmoid. The other infant had an atresia of the large intestine. Intestinal obstruction in newborn infants is in most instances due to a congenital anomaly of the gastro-intestinal tract.

INTUSSUSCEPTION

Of all the forms of intestinal obstruction studied in this series of cases, acute intussusception occurred most frequently. This disease was found in 22 patients of whom 15 were boys and 7 were girls. The ages varied from 4 months to 30 months, the largest number of patients being found at 7 months. Only 5 of these children were older than 1 year. The duration of illness prior to admission to the hospital varied from 1 hour to 7 days. Ten of the children were admitted within 12 hours after the onset of symptoms and 15 were admitted within 24 hours.

Symptoms. The classical group of symptoms in acute intussusception consists of abdominal pain which is sudden in onset and rhythmic in character, shock which is usually described by the mother as marked pallor, vomiting, and blood-stained mucus on the diaper. All of these symptoms need not be present to establish a diagnosis. Abdominal pain was reported as occurring in 17 patients, vomiting in 18, bloody mucus in 19, and sudden pallor in 10. In six histories no mention was made of shock and the occurrence of this symptom is undoubtedly much more frequent. The guiding symptoms in this disease are rhythmic abdominal pain, varying degrees of shock and blood stained mucus passed by rectum, all occurring suddenly in a child previously in good health. Vomiting may not be an early symptom and although constipation is characteristic there may be one or more stools. One child, 20 months old who had an umbilical hernia and was ill for 7 days with symptoms of abdominal pain, vomiting and diarrhœa and who showed bloody mucus in the stools, was admitted for reduction of an incarcerated umbilical hernia. Laparotomy revealed adherent omentum at the umbilicus and an ileocæcal intussusception.

Physical signs. The usual appearance of the little patient with acute intussusception is that of a child, generally a boy under 1 year, pale and at times markedly so who may be lying quietly, but at intervals will cry out as if in pain and draw up his little legs. The abdomen is distended and on palpation one can feel a sausage-shaped mass along the colon most often in the region of the transverse or descending portions. Visible peristalsis may be noted. Even so short a time as 1 hour after the onset of symptoms, but usually sev-

[1] Cohen. Torsion of uterine adnexa before puberty. J. Am. M. Ass., 1923, lxxx, 382-83.

eral hours later, bloody mucus is seen on the diaper or the examining finger. Tenesmus is seen only in those cases of long duration and was not noted in any of the records of the patients in this group. A boggy mass in the rectum, the apex of the intussusception, is not felt early in the disease. Rigidity and tenderness may be present. Enemata are ineffectual although at times the first returns may contain fæcal material. In this group of 22 patients, an abdominal mass was palpated in 17. One child who had two distinct masses, one along the ascending colon and another in the region of the splenic flexure, had two intussusceptions one of which was ileocæcal and the other ileo-ileal. Rectal masses were palpated in only two of the patients.

Varieties of intussusception. Most of the intussusceptions in this series were of the ileocæcal variety. In one child, a retrograde intussusception of the sigmoid extending to the transverse colon was found, another had an intussusception of a Meckel's diverticulum extending through ileum and cæcum, and another child had two intussusceptions as already noted.

Deaths from intussusception. There were 5 deaths among 19 children who were operated upon. In one child, the intussusception was reduced spontaneously before the child reached the hospital and 2 were cured by enemata. All deaths occurred in children who were sick 24 hours or longer. One child who died had a complicating pneumonia at the time of admission and developed a volvulus of the intestine as a postoperative complication. One of the children that died was ill for 5 days. The fact that 3 out of 22 children were cured without operation should not encourage the use of non-operative methods. To save the lives of these children the diagnosis must be made early and surgical treatment must be instituted as soon as the diagnosis is made.

CONCLUSIONS

In a series of 400 patients, all children 13 years of age and under, admitted to Lebanon Hospital for operation for acute abdominal diseases, there were two classes of patients, those suffering from inflammatory diseases and those suffering from diseases due to mechanical disturbances.

Acute appendicitis is represented by the greatest number of cases in the first group and it has been demonstrated that age, duration of illness prior to operation, and the administration of cathartics have a harmful effect on the course of the disease while previous attacks of acute appendicitis, contrary to general belief, do not seem to have an unfavorable effect on subsequent attacks.

Mesenteric lymphadenitis and pyelitis are often differentiated with difficulty from acute appendicitis. In pyelitis, however, urinary findings determine the diagnosis.

Primary peritonitis although represented by only 10 patients is important because of its usually fatal course. All patients suffering from this condition should be given the benefit of early operation as we are never certain that appendicitis is not the cause.

Acute intestinal obstruction is the most frequent abdominal disease in the group of mechanical derangements. Acute intussusception is the most frequent form of obstruction found and next in order is obstruction due to incarcerated inguinal hernia. Intestinal obstruction in the newborn is always due to a congenital anomaly of the gastro-intestinal tract. Early diagnosis and early operation in acute intussusception are life saving measures. One should not wait for all the classical symptoms and signs to determine diagnosis and treatment in this disease.

I am greatly indebted to all the members of the surgical staffs at Lebanon Hospital for permission to use records of their patients.

HEXYLRESORCINOL AS A GENERAL ANTISEPTIC

By VEADER LEONARD, M.D., F.A.C.S., and WILLIAM A. FEIRER, Sc.D., Baltimore
From the Department of Bacteriology, School of Hygiene and Public Health, Johns Hopkins University

THE QUALIFICATIONS ESSENTIAL TO AN EFFECTIVE TISSUE SURFACE DISINFECTANT

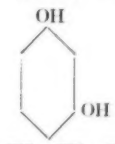
THE disinfection of tissue surfaces, such as skin, mucous membranes, denuded areas, wounds, etc., presents one of the most fundamental problems in surgery. In the course of various investigations with new antiseptic substances carried out in this laboratory during the past few years, certain conclusions have been drawn regarding the failure of most germicides in tissue surface disinfection, from which have been evolved a series of qualifications regarded as essential to an effective general antiseptic intended for use in this field. Such a substance should be (1) chemically stable, (2) non-toxic, (3) non-irritating, (4) rapidly bactericidal in high dilutions, (5) highly penetrating, (6) unaffected by organic matter. Freedom from stain and objectionable odor may be noted as highly desirable properties although they are not essential.

The interest attaching to a study of the alkyl resorcinols as internal antiseptics, since one of the writers originally described the biological properties of this series (12, 13), has delayed an investigation of their possible application as general antiseptics, a field which would ordinarily have been investigated first. This group of compounds, comprising the most powerful phenolic germicides known, has now been thoroughly studied. Certain information of fundamental importance bearing on the relationship of chemical constitution to bactericidal activity and the rôle of certain physical properties of germicidal solutions in largely determining their efficiency in surface disinfection, has been gathered in the course of this work and will be discussed briefly in so far as it relates to the subject.

ALKYL RESORCINOLS

As a rule, increased toxicity and irritant properties go hand in hand with increased germicidal power. As a group, the alkyl resorcinols exhibit a combination of properties which is entirely unique in that the enormous increase in germicidal power which accompanies each increase in the number of carbon atoms in the alkyl chain, from 3 to 4, 5, and 6 (Fig. 1) is accompanied by no increase whatever in toxicity to laboratory animals while the irritant properties of the successive compounds actually becomes diminished.

Hexylresorcinol, the most powerful member of this series according to the United States Hygienic Laboratory method of measuring germicidal values, is now known to possess a phenol coefficient of 72 (9). Its structural formula (5, 10, 11) is as follows:



$CH_2.\ CH_2.\ CH_2.\ CH_2\ CH_2.\ CH_3.$

When it is considered that this compound shows an increase in germicidal power over that of resorcinol, its mother substance, of over twenty thousand per cent (20,000 per cent) without any increase in toxicity or irritant properties, and that the intermediate members of the series show regular and proportionate development of these properties with each increase in the weight of the alkyl chain, it would appear that a fundamental relationship between chemical constitution and the particular properties to be desired in a germicide has been definitely established for this type of compound.

HEXYLRESORCINOL

With reference to the properties of hexylresorcinol in relation to the six qualifications enumerated above as essential to an effective surface disinfectant, the first three may be dismissed very briefly.

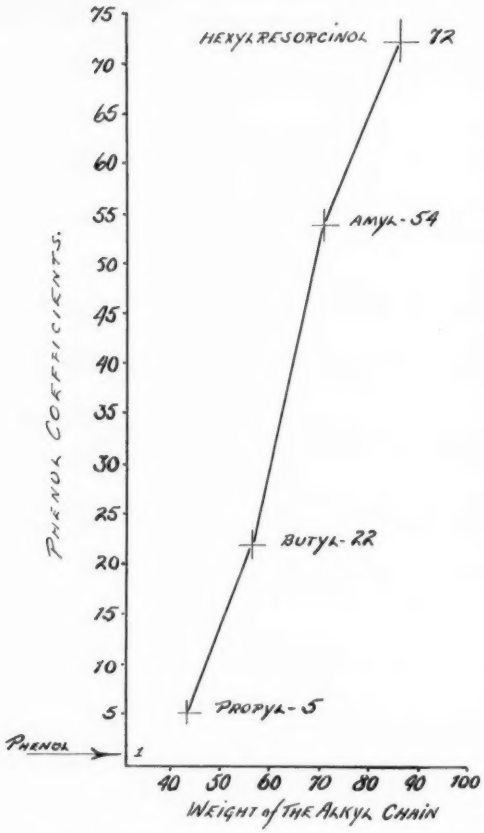


Fig. 1. The bactericidal power of the alkyl resorcinols increases in direct proportion to the sum of the atomic weights of the atoms in the alkyl chain. The phenol coefficients are shown opposite each compound. The level of the bactericidal power of phenol (unity) is shown in the lower left corner.

1. Hexylresorcinol is a stable chemical compound. Aqueous solutions retain their bactericidal activity after months of standing at room temperature.

2. Hexylresorcinol is non-toxic. It can be administered to man in large doses (0.6 gram three or four times daily) for a year or more without any untoward effect (4). It is by far the most powerful germicide ever described as a non-toxic substance.

3. Highly bactericidal dilutions of hexylresorcinol are absolutely devoid of irritant properties.

A study of the possibilities of the alkyl resorcinols as tissue surface disinfectants originated in the observation that aqueous solutions of hexylresorcinol which would destroy all the common pathogens so quickly (less than 15 seconds) that the time could not be accurately determined, appeared to be entirely devoid of irritant properties. Examination of all of the commonly used antiseptics and germicides indicated that their relative inefficiency in tissue surface disinfection was due chiefly to the fact that highly active dilutions were almost invariably found to be highly irritating as well.

A detailed investigation of the unique properties of hexylresorcinol has now furnished a satisfactory explanation of the astonishing speed and power of its bactericidal action. A summary of this work necessarily involves a brief discussion of the mechanism of disinfection by chemical means, in association with the physical factor known as surface tension.

THE RÔLE OF SURFACE TENSION IN DISINFECTION BY CHEMICAL MEANS

Respiration, nutrition, and the excretion of waste products by all vegetative cells, bacteria included, is carried on exclusively by diffusion of the various substances concerned in their metabolism, through the limiting cell membrane. Only in this manner may the living protoplasm contained within this membrane continue its existence (Fig. 2A).

The poisoning of a bacterial cell by a germicide in solution is dependent upon the diffusion of the disinfecting substance through the cell wall, which may or may not be destroyed in the process. The destruction of the protoplasm is now generally regarded in the light of a chemical reaction between it and the germicidal substance (Fig. 2, B and C). This view is based upon experimental evidence by a number of investigators, notably Chick (2), who has shown that disinfection by chemical means is an orderly time process exhibiting all of the mathematical characteristics of a unimolecular reaction, such as the hydrolysis of proteid or cane sugar.

Were we dealing with naked protoplasm, disinfection by chemical means would probably

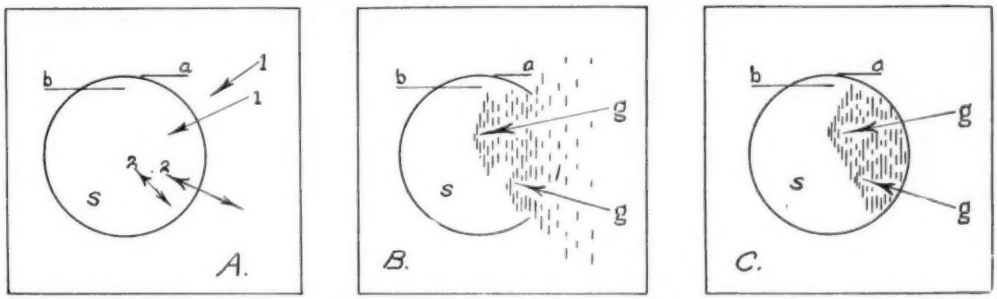


Fig. 2. Diffusion in vital processes and in chemical disinfection. S, a spherical organism; a, the cell wall; b, the protoplasm. In A, *1* represents the diffusion of nutritive material through the cell wall; *2* represents the respiratory exchange and excretion of waste products by diffusion through the cell wall. In B is shown the diffusion of germicide, *g*, into the bacterial cell with destruction of the cell membrane and escape of poisoned protoplasm. In C is shown the diffusion of germicide, *g*, into the cell without destruction of its limiting membrane, the death of the organism resulting from a chemical reaction between the protoplasm and germicide, represented by the shaded area.

follow the laws governing all chemical reactions between reactive substances in solution. The situation is complicated by the fact that one reagent (the protoplasm) is separated from the other (the germicide) by a semipermeable membrane (the cell wall) through which the latter must diffuse before the reaction (disinfection) can occur. It is evident, therefore that the germicide, to be active, must exist in solution and that any factor which would tend to increase the rate of its diffusion through the cell wall would increase its bactericidal efficiency.

Now it has been observed (8) that if a surface tension reducent is added to a germicidal solution, both the velocity of disinfection and actual bactericidal power of that particular dilution of the germicide may be markedly increased in spite of the fact that the substance added has no toxic action whatever on the test organism. This phenomenon is due to *an increase in the rate of diffusion of the germicide into the bacterial cell* (*1*).

As illustrated diagrammatically in Figure 3, a certain number of molecules of a germicide in solution will diffuse through the cell wall of the organism within a given time (Fig. 3, A). On the addition of a surface tension reducent which has no antiseptic action whatever, the rate of this diffusion is increased

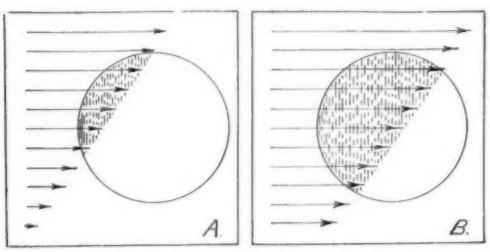


Fig. 3. The influence of surface tension on the rate of diffusion. The circles represent spherical organisms; the arrows represent molecules of germicide. The rate of diffusion is indicated by the progress of the arrows from left to right within a given time. A shows diffusion of the germicide through the cell membrane in a given time. B, on lowering the surface tension of the solution, diffusion is accelerated and the organism receives a larger amount of germicide within the same time interval. Consequently, higher germicidal values are obtained for the same concentration of germicide.

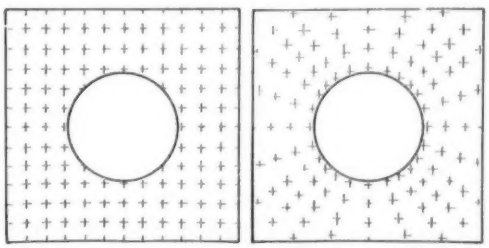


Fig. 4. The adsorption, by bacteria, of germicides which reduce surface tension. The circle represents a spherical organism in suspension in a germicidal fluid. Left figure shows dispersion of molecules in solution of a germicide which does not reduce surface tension showing equal distribution of the germicide throughout the solution. Right figure shows concentration of molecules of a germicide which itself reduces surface tension about the surface of the organism, by mechanical adsorption. The rate of diffusion of the germicide into the cell is also increased under these circumstances.

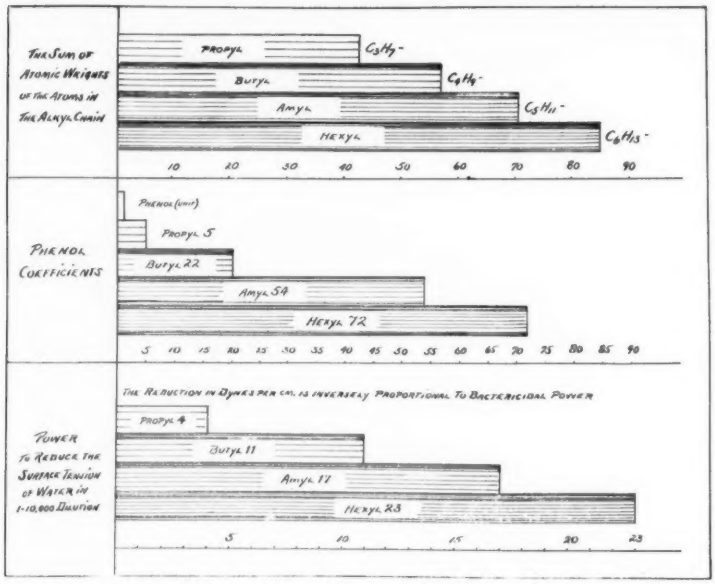

The Sum of Atomic Weights of the Atoms in the Alkyl Chain
Propyl C_3H_7-
Butyl C_4H_9-
Amyl C_5H_{11}-
Hexyl C_6H_{13}-
10 20 30 40 50 60 70 80 90
Phenol Coefficients
Phenol (unit)
Propyl 5
Butyl 22
Amyl 54
Hexyl 72
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
The Reduction in Dynes per cm. is Inversely Proportional to Bactericidal Power
Power to Reduce the Surface Tension of Water in 1-10,000 Dilution
Propyl 4
Butyl 11
Amyl 17
Hexyl 23
5 10 15 20 23

Fig. 5. The bactericidal power of the alkyl resorcinols increases in direct proportion to the weight of the alkyl chain and their power to reduce the surface tension of water.

(Fig. 3, B). In an equal length of time, the organism is penetrated by a larger amount of the germicide. This naturally increases *the velocity* of disinfection and therefore higher germicidal values are obtained with the same dilution of the germicide, within the time limits of the experiment.

It is a well-known fact that substances which reduce the surface tension of their solvents tend to collect about any surface or particle which may be in contact with the solution. This phenomenon is known as mechanical adsorption and the extent to which a surface tension reducent in solution will collect about particles in suspension is directly proportional to its surface tension reducent properties. Germicides which dissociate readily in solution, such as hydrochloric acid, may be electrically adsorbed by oppositely charged particles, with little or no effect on the surface tension of the solution. If two surface tension reducents are present in the same solution, the more powerful one will displace the weaker one from these surfaces.

Bearing these fundamental physical factors in mind, it is evident that *if the germicide itself is a surface tension reducent* its molecules, which would be equally distributed throughout the solution in the absence of any solid particles in suspension in it, such as bacteria, would be immediately adsorbed upon the surfaces of any bacteria (or other particulate matter) which might be added to the solution (Fig. 4).

Thus, germicidal substances which reduce the surface tension of their solutions actually become concentrated at the most effective point, i.e., on the surface of the organism. The concentration of such a germicide in the immediate vicinity of an organism suspended in a solution containing the germicide in a dilution, for instance, of *1: 1000 will be actually greater than 1: 1000*. Add to this the fact that under these circumstances the rate of diffusion of the germicide into the bacterial cell is accelerated and it becomes plainly evident that, other things being equal, *a germicide which reduces surface tension will be more efficient than one which does not* (8).

Hexylresorcinol is an extremely powerful surface tension reducent. Its activity in this regard is practically equivalent to chemically pure sodium oleate (14, 15). The relation of surface tension reduction by closely allied compounds to their actual bactericidal power is beautifully illustrated by the alkyl resorcinols. With each increase in the weight of the alkyl chain in the successive compounds of this series up to the hexyl derivative, the power to decrease the surface tension of water is sharply and regularly increased.

This increase is directly proportional to both the sum of the atomic weights of the atoms in the alkyl radical and to the increased germicidal power exhibited by each successive compound. This relationship is shown graphically in Figure 5. Hexylresorcinol occupies the peak in this series. Were it not for the fact that a sudden decrease in water solubility occurs in the higher derivatives (heptyl, octyl, nonyl, decyl, etc.), this process could be extended indefinitely with the development of germicidal compounds of enormous potentialities.

Figure 6 illustrates the surface tension apparatus devised by Count du Noüy (6) which was employed in making all of the surface tension measurements reported in this paper.

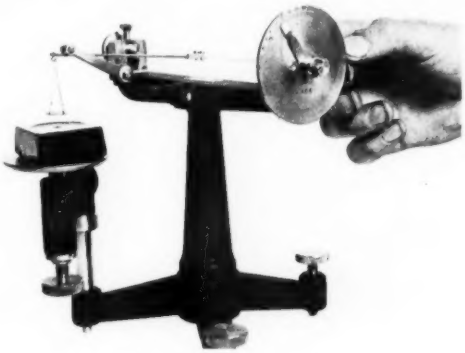


Fig. 6. The du Noüy surface tensiometer (6).

THE INFLUENCE OF SURFACE TENSION ON THE PERMEABILITY OF BACTERICIDAL SOLUTIONS

All tissue surfaces contain numerous microscopic crevices and interstices, the depths of which may contain large numbers of organisms. The penetration of the disinfecting solution into the depths of these irregularities in surface is absolutely essential to complete disinfection. Here, again, the solution of low surface tension possesses great advantages, as illustrated by many familiar phenomena. For instance, oils will soak readily through thick wooden planks and alcohol or ether will be immediately absorbed by closely woven fabrics upon the surface of which water remains as discrete droplets. While, as Frobisher (8) has indicated, certain limitations due to viscosity and capillary rise must be considered in interpreting any generalization, it may be stated that under equivalent conditions, *the strong retaining surface film of the fluid of high surface tension prevents its*

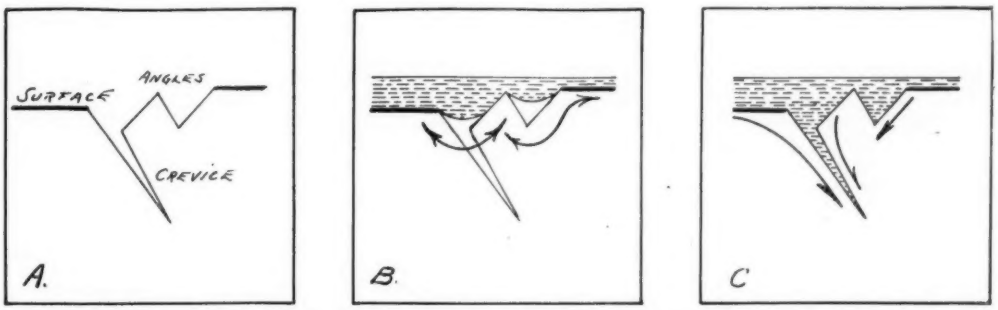
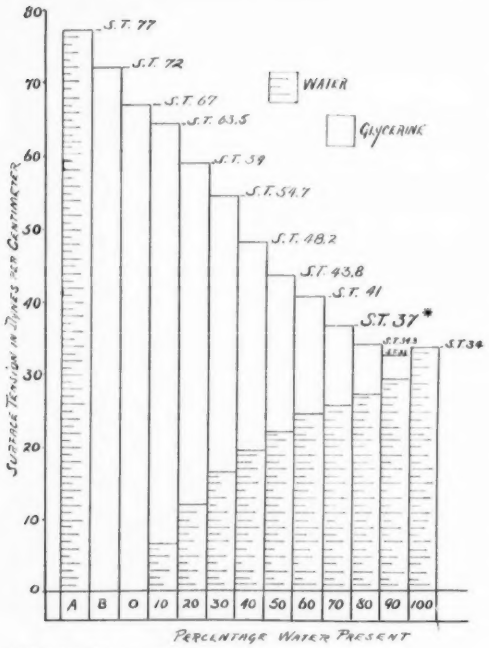


Fig. 7. Penetration by fluids of low surface tension. A, Microscopic irregularities in surface. B, The same surface covered by a fluid of high surface tension. The strong retaining surface film prevents its extension into the depths of angles and crevices, C, The same surface covered by a fluid of low surface tension. The readily extensible surface film allows a labile process to flow into each irregularity in surface.



*Solution S.T. 37. Optimum.

Fig. 8. Depression of the surface tension of solutions of hexylresorcinol (1:1000) in aqueous glycerine as the percentage of water is increased. A, Pure water; B, pure glycerine; 0, pure glycerine with 1:1000 hexylresorcinol; 100, pure water with 1:1000 hexylresorcinol; 10–90, percentage of water in each solution. Height of column indicates surface tension.

extension into minute crevices and interstices, the depths of which may be readily penetrated by the easily extensible surface film of the fluid of low surface tension (Fig. 7).

The power and velocity of bactericidal action shown by high dilutions of hexylresorcinol, as well as the penetrability of these solutions, are closely associated with its marked surface tension reducent properties. The fact that hexylresorcinol is a powerful surface tension reducent, in addition to its inherent germicidal properties, enables it to meet the fourth and fifth qualifications enumerated above.

FACTORS DETERMINING THE CHOICE OF A SOLVENT FOR HEXYLRESORCINOL

The problem of finding a suitable medium or vehicle by which hexylresorcinol could be employed as a general antiseptic without loss of any of its advantages, has been one of considerable difficulty, owing to its sparing solubility in water. A large number of organic solvents have been investigated and discarded for one reason or another. Glycerine was finally selected as the solvent to which the fewest objections could be raised.

Surface tension measurements of glycerine solutions containing various concentrations of hexylresorcinol furnished very unexpected results. In spite of its power to reduce the surface tension of water, hexylresorcinol was found to reduce the surface tension of glycerine only to a comparatively slight extent. This objection would have ruled out glycerine as a solvent had it not been found that the presence of water in these solutions released the surface tension depressant properties of the hexylresorcinol. Investigation of this seemingly anomalous situation, in which the addition of pure water to a solution reduced its surface tension in direct proportion to the amount of water present, has yielded experimental results which offer striking proof of the accuracy of Frobisher's deductions and the ideas expressed in this paper relative to the influence of surface forces in chemical disinfection. The details of these experiments are being published elsewhere (16).

In a study of solutions containing various proportions of hexylresorcinol, glycerine, and water, the following requirements were sought:

1. Sufficient hexylresorcinol present to insure very rapid disinfection (15 seconds) at body temperature not only in the original solution but in those dilutions which might result from its application to moist mucous membranes.

2. Sufficient glycerine present to ensure perfect solution of the hexylresorcinol under any conditions of dilution with water.

3. Sufficient water present in the glycerine to secure the lowest possible surface tension.

4. A minimum of irritant properties.

Without repeating the details of the experiments which led to its selection (16), the exact composition finally chosen as best meeting these four requirements was found to be *a solution consisting of 30 per cent glycerine and 70 per cent water in which is dis-*

solved one milligram of crystalline hexylresorcinol per cubic centimeter and which possesses a surface tension of 37 dynes per centimeter.[1]

As a matter of convenience this particular composition has been designated as "solution S.T. 37" and will be referred to as such in the remainder of this paper.

Figure 8 illustrates the striking effect of increasing percentages of water on the surface tension of solutions of aqueous glycerine each containing 1 milligram of crystalline hexylresorcinol per cubic centimeter.

In the preparations containing 80 per cent and 90 per cent of water, there is insufficient glycerine present to hold the hexylresorcinol in solution.

THE PROPERTIES OF SOLUTION S.T. 37

Bactericidal properties are ordinarily determined by the employment of time intervals in test tube experiments ranging from 2½ to 15 minutes or longer. The astonishing rapidity with which all of the commoner pathogenic test organisms were destroyed necessitated a reduction of these time intervals to a matter of seconds. Even under these circumstances the shortest time which could be employed with accuracy (15 seconds) was found to be too long, in that every type of test organism exposed to solution S.T. 37 for this period was invariably destroyed (see Table I).

Such organisms as endamœba coli, iodamœba williamsi; spirochætæ, such as leptospira icterohæmorrhagicæ and various flagellates such as trypanosoma lewisi and trichomonas hominis[2] are instantly destroyed and disappear completely on contact with solution S.T. 37 in less than 5 seconds.

Since any germicidal solution must suffer at least some dilution when applied to a moist surface such as a mucous membrane, the bactericidal activity of various dilutions of solution S.T. 37 was determined, employing staphylococcus aureus and bacillus typhosus as test organisms. The results are shown in Table II. The details of the technique are being published elsewhere and will not be repeated (16).

[1] One dyne is equivalent to a lifting force of $_{981}$ gm.

[2] We are indebted to Dr. L. B. Lange and to Mr. Conrad Bauer of the Department of Medical Zoology for this material.

Even in a dilution of 1 to 10, solution S.T. 37 retains sufficient bactericidal power to destroy bacillus typhosus in less than 15 seconds and staphylococcus aureus in less than 1 minute.

This observation is of importance in clinical application in that the solution may be diluted to considerable bulk, for such purposes as irrigation, without destroying its rapid bactericidal properties. It should be noted, however, that the surface tension rises with each dilution as shown in Table II. This undoubtedly reduces the permeability of the solution to some extent but since the highest surface tension recorded (53 dynes per centimeter for the 1-10 dilution) is still very low, being 24 dynes per centimeter less than that of water, this increase in surface tension should not interfere very materially with the efficiency of the solution.

The stability of solution S.T. 37 in the presence of organic matter in the form of a standard mixture containing 2 per cent of peptone and one per cent of gelatine, together with the bactericidal activity of various dilutions tested under these circumstances is shown in Table III. Dilutions higher than that obtained on the addition of three parts of water were not investigated since this dilution is absolutely devoid of irritant properties even when applied to the most sensitive mucous membranes. Its bactericidal activity is fully retained nevertheless (15 second standard) under conditions (Table III) which largely or completely destroy the microbicidal power of most germicides.

The optimum dilutions of solution S.T. 37 for use in the disinfection of various tissue surfaces appears to be, within certain limits, a matter to be determined by the individual case. The solution may be used full strength on the skin, in fresh cuts and abrasions, on granulating surfaces, and in abscess cavities and sinuses. It may also be employed full strength in topical applications in the ear, nose and throat, mouth, etc.

Instillations of solution S.T. 37 diluted with either one or two parts of water depending on the case, may be employed in the urethra and bladder and for renal pelvic lavage.

TABLE I.—THE VELOCITY OF BACTERICIDAL ACTION OF SOLUTION S.T. 37
+ MEANS GROWTH; o, STERILE

Test organisms	Control	15 sec.	30 sec.	60 sec.	Culture media
Bacillus coli	+	o	o	o	Witte peptone broth.*
Bacillus typhosus	+	o	o	o	Witte peptone broth.*
Bacillus pyocyaneus	+	o	o	o	Witte peptone broth.*
Bacillus proteus	+	o	o	o	Witte peptone broth.*
Staphylococcus albus	+	o	o	o	Witte peptone broth.*
Staphylococcus aureus	+	o	o	o	Witte peptone broth.*
Bacillus diphtheriæ	+	o	o	o	Beef infusion broth.
Bacillus hofmanni	+	o	o	o	Beef infusion broth.
Streptococcus hæmolyticus	+	o	o	o	Beef infusion broth.
Streptococcus viridans	+	o	o	o	Beef infusion broth.
Pneumococcus, Type I	+	o	o	o	Beef infusion broth.
Pneumococcus, Type IV	+	o	o	o	Beef infusion broth.
Micrococcus catarrhalis	+	o	o	o	Beef infusion broth.
Micrococcus meningitis	+	o	o	o	Beef infusion broth.
Micrococcus gonorrhœa	+	o	o	o	Brain infusion broth.
Spirillum metchnikovi	+	o	o	o	Witte peptone broth.

*American Public Health Association Standard (15) (pH 6.6–6.8)

TABLE II.—THE VELOCITY OF BACTERICIDAL ACTION OF VARIOUS DILUTIONS OF SOLUTION S.T. 37. + MEANS GROWTH; o, STERILE

Dilutions of solution S. T. 37 with distilled water	S.T.*	Bacillus typhosus†				Staphylococcus aureus‡			
		Control	15 sec.	30 sec.	60 sec.	Control	15 sec.	30 sec.	60 sec.
With one part water	39.6	+	o	o	o	+	o	o	o
With two parts water	43.	+	o	o	o	+	o	o	o
With three parts water	45.7	+	o	o	o	+	o	o	o
With four parts water	47.	+	o	o	o	+	o	o	o
With five parts water	49.	+	o	o	o	+	o	o	o
With six parts water	50.4	+	o	o	o	+	o	o	o
With seven parts water	51.1	+	o	o	o	+	o	o	o
With eight parts water	51.1	+	o	o	o	+	+	o	o
With nine parts water	53.1	+	o	o	o	+	+	+	o

* Surface tension in dynes per centimeter. † Hopkins strain. Phenol coefficient standard. ‡ This strain previously described (7).

TABLE III.—THE STABILITY OF SOLUTION S.T. 37 IN THE PRESENCE OF ORGANIC MATTER

Dilutions of solution S.T. 37 each containing 2 per cent peptone and 1 per cent gelatine	Bacillus typhosus*				Staphylococcus aureus*			
	Control	15 sec.	30 sec.	60 sec.	Control	15 sec.	30 sec.	60 sec.
Undiluted	+	o	o	o	+	o	o	o
Diluted with one part water	+	o	o	o	+	o	o	o
Diluted with two parts water	+	o	o	o	+	o	o	o
Diluted with three parts water	+	o	o	o	+	o	o	o

* See footnote, Table II.

Diluted with two volumes of water solution S.T. 37 may be instilled in the normal conjunctival sac.

For irrigations of any tissue surface in which a considerable bulk of fluid is essential and also as wet dressings on infected wounds and denuded surfaces, dilutions up to 1:5 may be employed (see Table II).

Clinical results with solution S.T. 37 in tissue surface disinfection will be reported in subsequent communications.

CONCLUSIONS

A solution containing 30 per cent of glycerine and 70 per cent of water in which is dissolved 1 milligram of crystalline hexylresorcinol per cubic centimeter, possesses a surface tension of 37 dynes per centimeter (solution S.T. 37) and represents the optimum composition of the solutions investigated for the following reasons:

1. It is stable and non-toxic.

2. All the major types of pathogenic microorganisms are destroyed in less than 15 seconds on contact with this solution.

3. Its bactericidal power is fully retained (15 second standard) in dilutions which are absolutely devoid of irritant action on the most delicate tissue surfaces.

4. Its bactericidal power is fully retained (15 second standard) in all dilutions likely to be encountered in clinical application as well as those found in the presence of organic matter.

5. The hexylresorcinol is held in perfect solution in all dilutions.

6. The surface tension of the solution is very low.

7. It is water clear and odorless.

8. It does not attack any of the heavy metals.

REFERENCES

1. Billard, G. Compt. rend. Soc. Biol., 1906, lx, 1056.
2. Chick, Harriette. Tr. viii Internat. Cong. Appl. Chem., 1912, xxvi, 167.
3. Committee on Standard Methods of Examining Disinfectants. Am. J. Pub. Health, 1918, viii, 508.
4. Damon, S. R. Am. J. Pub. Health, 1927, xvii, 279.
5. Dohme, A. R. L. D., Cox, E. H., and Miller, Ellis. J. Am. Chem. Soc., 1925, xlviii, 1688.
6. Du Noüy, P. J. Gen. Physiol., 1919, i, 521.
7. Feirer, W. A., and Leonard, Veader. J. Am. Dent. Ass. 1927, xiv, 1049
8. Frobisher, Martin. J. Bacteriol., 1927, xiii, 163.
9. Hampil, B. To be published.
10. Johnson, Treat B., and Hodge, W. J. Am. Chem. Soc., 1913, xxxv, 1014.
11. Johnson, Treat B., and Lane, F. W. J. Am. Chem. Soc., 1921, xliii, 348.
12. Leonard, Veader. J. Am. M. Ass., 1924, lxxxiii, 2005.
13. Idem. J. Urol., 1924, xii, 585.
14. Leonard, Veader, and Frobisher, Martin. Tr. Am. Ass. Genito-Urins. Surg., 1925, xviii, 333.
15. Leonard, Veader, and Frobisher, Martin. J. Urol., 1926, xv, 1.
16. Leonard, Veader, and Feirer, W. A. Bull. Johns Hopkins Hosp., 1924, xli, 21.

OBSERVATIONS ON THE PREVENTION OF POSTOPERATIVE PERITONITIS AND ABDOMINAL ADHESIONS[1]

By HEBERT L. JOHNSON, M.D., Boston, Massachusetts

IN dealing with the subject of prevention of peritonitis and abdominal adhesions, one must review the normal method of reaction to peritoneal inflammation.

Deaver (1) writing upon the subject of adhesions, classified them into two main groups: congenital and acquired. With the congenital we are not concerned as their origin or function has not been proven. The acquired adhesions are subdivided into two natural divisions: inflammatory and operative. Inflammatory adhesions may be constructive as well as destructive. This latter sub-classification is entirely in keeping with my own observations, the constructive adhesions representing the deposit of fibrin in the primary reaction against peritoneal inflammation, and the destructive corresponding to fibrin which has become firmly organized into dense unabsorbable adhesions.

Among the causes of abdominal adhesions, mentioned by Deaver, are collections of blood in the peritoneal cavity, sutures, ligatures, use of the cautery, exposure of the viscera, chemical irritation, and infection. The prophylaxis offered by Deaver against this complication is a careful operative technique, strict asepsis, avoidance of trauma, and visceral exposure. Nothing in my method lowers this standard of careful operative technique.

This same author, in referring to the early reaction to an inflammatory process or a beginning peritonitis, describes a serous effusion containing phagocytic cells. In addition to this serous effusion, there is formed a fine layer of fibrin which covers the visceral layer of the peritoneum. The agglutination of the coils of bowel (constructive adhesions) is due to their being covered by this fine layer of fibrin. This latter serves to protect the endothelium from the action of toxins and enables the intestinal surfaces to adhere, thus mechanically limiting the spread of infection. It also provides fine strands or ladders along which the phagocytes may travel on their way to the scene of action. This fibrinous exudate, in the absence of a severe peritonitis or extensive trauma, is usually absorbed before adhesions have had a chance to form. The method of this absorption is well brought out by McCallum (3).

"Many writers have recognized the power of certain tissues to digest themselves *in vitro* (autolysis) and have observed the neutrophile leucocytes produce a strong proteolytic ferment capable of digesting fibrin, gelatin, etc. Most of them, however, according to Wienes, have denied the production of a ferment of lymphoid cells. Opie has cleared the matter up very well by finding that the ferments of different cells required for their activity different reactions. He states that the polymorphonuclear neutrophile leucocytes and their ancestral granulated cells produce a trypsin-like ferment which acts best in an alkaline or neutral medium to digest proteins. Its action is often combated by an anti-enzyme which is present in the plasma of the blood and other body fluids. It is resistant to heat up to 70 or 75 degrees centigrade, and is therefore quite different from the complement of the serum which is destroyed at 55 degrees centigrade. When formed in great concentration in a focal area of inflammation the enzyme far outstrips the neutralizing anti-enzyme and brings about the liquefaction of dead tissue as in the case of an abscess. Large collections of fluid tend to retard its action.

"This proteolytic ferment Opie calls leucoprotease. While these ferments are evidently used inside the cell in the case of the particles which have been ingested, it seems certain that in the formation of pus, as in the abscessed bodies, they are diffused from the bodies of the disintegrating leucocytes and in the free fluid effect the solution of the adjacent injured and dead tissue. This function of the wandering cells is of course of immediate importance in connection with their task of cleaning up the injured area to prepare it for re-

[1] Read before the combined staffs of the Fifth Avenue Hospital, New York, March 2, 1927.

pair. While the proteases thus produced are active in the solution of undesirable material their unbridled action might be detrimental. As a matter of fact, it is shown by Jobling and Peterson that the antiferment known to be present in the serum and to restrict the action of the ferment is a recognizable chemical substance, usually a soap or other combination of an unsaturated fatty acid. It is possible to remove or decompose this substance or to saturate the fatty acid with iodine and thus release the ferment to its full activity. The presence of excess of such soaps in the tubercle bacilli seems to be the cause of the delay of liquefaction of tissue brought to necrosis by this bacilli. It is seen from this that we are at the beginning of our knowledge of the activities of wandering cells. Other ferments they produce have been as yet only imperfectly studied although we have evidence that others, such as oxydases are produced by some of them and there are surely more of them."

From the long list of previous attempts at prevention of abdominal adhesions by a foreign substance, we are justified in concluding that no one method has proven satisfactory. It is apparent from the known chemical action of some of the substances used, such as boric acid, sodium citrate salt solution, gelatin, gum, and paraffin that many previous writers sought to prevent rather than stimulate the normal reaction against peritoneal trauma and infection.

Prominent among those recently contributing to the work on this subject is a Japanese surgeon, Takashi Kubota (2) of the Surgical Department of the Imperial University, Fu Kuoka, Japan. His method of experimentation was first to determine a reliable method of producing adhesions on the experimental animal. This was accomplished by rubbing the bowel with dry gauze until ecchymosis appeared and then painting with tincture of iodine 2 per cent, Lugol's solution, or 5 per cent silver nitrate. He then used any of the then known methods of preventing abdominal adhesions. Behan recommended the use of 5 per cent boric acid solution. Pope used 2 per cent sodium citrate with 3 per cent hypertonic salt solution. Walker used 3 per cent sodium citrate with 1 per cent salt solution. The end-result of experiments done by these methods was medium or strong adhesions. Vogel prescribed the use of sodium citrate, sodium chloride, and gum arabic solution. A combination of humanol and liquid fat of animals of the same species recommended by Loeffler, Hoellaender, Edin, Lindig, and Lachenberg gave better results than the other methods but still showed some adhesions. The gelatin acacia mixture prescribed by Williamson and Frank also gave medium adhesions.

Having determined the unsatisfactory results of these previous methods, Kubota planned a series of experiments on rabbits, using papain as the prevention agent. He used dilutions of this substance ranging from 1:1,000, to 1:1,000,000. Anything less than 1:1,000 produced a marked inflammatory reaction with resultant adhesions, and any dilution over 1:500,000 also resulted in adhesions. The dilution which gave best results was 1:200,000. This substance was applied to the eroded peritoneal surface and the abdomen closed. Inspections were made at frequent intervals, ranging from 2 days to 4 weeks. Kubota has graphically charted (Tables I, II, and III) the results of these experiments as compared with the first series in which previously known agents were used.

It may be of interest at this point to speak of the origin and chemical properties of papain, as taken from Thorpe's *Dictionary of Applied Chemistry*. Papain is "a vegetable digestive ferment obtained from the unripe fruit of carica papaya, or the pawpaw tree, active in neutral and alkaline media. The juice, when dry, forms a powder resembling gum arabic. Papain is the alcoholic extract. Its action depends on the fact that it digests not only muscle fibre but connective tissue. It digests fibrin and albumin in neutral and slightly alkaline media. When injected into the circulation in large doses it paralyzes the heart. In small quantities, it appears to favor the multiplication of micrococci in the blood."

In January, 1925, Naumann (4), of Germany, published a paper on the biological prevention of abdominal adhesions. Basing his conclusions on the fact that an

TABLE I

Rabbits	Causes of adhesion	No. of days until examination	Adhesion	Remarks
1	Rub. and 2% tincture iodine	24 hours	+	Slight fibrous adhesion.
2	Rub. and 2% tincture iodine	3 days	+	Slight adhesion.
3	Rub. and 2% tincture iodine	1 week	+	A firm adhesion around the small and large intestine and great omentum forming a large mass.
4	Rub. and 2% tincture iodine	2 weeks	+	
5	Rub. and 2% tincture iodine	3 weeks	+	
6	Rub. and 2% tincture iodine	6 weeks	+	
7	Rub. and Lugol solution	24 hours	+	Slight fibrous adhesion.
8	Rub. and Lugol solution	3 days	+	Slight adhesion.
9	Rub. and Lugol solution	1 week	+	A firm adhesion around the small and large intestine and great omentum forming a large mass.
10	Rub. and Lugol solution	3 weeks	+	
11	Rub. and 5% silver nitrate	24 hours	+	Slight fibrous adhesion.
12	Rub. and 5% silver nitrate	1 week	+	Firm adhesion.
Dogs. 1	Rub. and 2% tincture iodine	1 week	+	Firm adhesion.
2	Rub. and Lugol solution	2 weeks	+	

Notes: The solutions were applied to rabbits at cæcum, appendix and ascending colon extending for 10 centimeters. In dogs the small intestine was used.

TABLE II

Rabbits	Causes of adhesion	Preventive methods	Amount of injection	No. of days until examination	Adhesion	Remarks
13	Rub. and 2% tincture iodine	5% boracic acid	5 gm.	4 days	+	Slight fibrous adhesions.
14	Rub. and Lugol solution		5 gm.	2 weeks	+	Firm adhesions.
15	Rub. and 2% tincture iodine		10 gm.	4 weeks	+	
16	Rub. and 2% tincture iodine	2% Sodium citrate	100 c.cm.	4 days	+	Slight fibrous adhesions.
17	Rub. and 2% tincture iodine	3% Sodium chloride	100 c.cm.	1 week	+	Medium adhesions.
18	Rub. and 2% tincture iodine		100 c.cm.	3 weeks	+	
19	Rub. and 2% tincture iodine	3% Sodium citrate	100 c.cm.	2 weeks	+	Medium adhesions.
20	Rub. and Lugol solution	1% Sodium chloride	100 c.cm.	3 weeks	+	
21	Rub. and 2% tincture iodine	Sodium citrate 0.05	5 c.cm.	3 weeks	+	Slight adhesions.
22	Rub. and 2% tincture iodine	Sodium chloride 1.8	30 c.cm.	2 weeks	+	Medium adhesions.
23	Rub. and 2% tincture iodine	Gum arab. q. s. ad. 200.0	50 c.cm.	3 weeks	+	
24	Rub. and Lugol solution	Humanol	10 c.cm.	1 week	+	Slight adhesions.
25	Rub. and 2% tincture iodine		10 c.cm.	2 weeks	+	
26	Rub. and Lugol solution	Hare-oil	10 c.cm.	3 days	+	Slight adhesions.
27	Rub. and 2% tincture iodine		20 c.cm.	4 weeks	+	
28	Rub. and 5% silver nitrate	Gum arab. and gelatin added (25% each). Salt solution 50%	5 c.cm.	3 days	+	Medium adhesions.
29	Rub. and 2% tincture iodine		5 c.cm.	4 days	+	
30	Rub. and Lugol solution		10 c.cm.	1 week	+	

exudate-rich peritonitis often heals up without adhesions and that in this recovery the peritoneal tissues play the offensive rôle, he produced experimentally on the dog so-called sterile abscesses by the injection of turpentine oil together with a great quantity of physio-

TABLE III

Rabbits	Causes of adhesion	Kaktol solution %	Doses	No. of days until examination	Adhesion	Remarks
31	Rub. and 2% tincture iodine	0.0001	10 c.cm.	8 days	+	Slight fibrous adhesions around cæcum, colon, and appendix.
32	Rub. and 2% tincture iodine	0.0002	10 c.cm.	10 days	+	Weak adhesions in mesentery of ascending colon and appendix.
33	Rub. and Lugol solution	0.0004	10 c.cm.	1 week	−	Almost no adhesion of intestines.
34	Rub. and 2% tincture iodine	0.0004	10 c.cm.	4 weeks	−	
35	Rub. and Lugol solution		10 c.cm.	2 days	−	No adhesions.
36	Rub. and 2% tincture iodine		10 c.cm.	2 days	−	No adhesions of intestines; slight adhesion of mesentery.
37	Rub. and 2% tincture iodine	0.0005	10 c.cm.	2 weeks	−	No adhesions.
38	Rub. and Lugol solution		10 c.cm.	4 weeks	−	
39	Rub. and 2% tincture iodine	0.0006	10 c.cm.	10 days	−	No adhesions
40	Rub. and Lugol solution	0.0008	10 c.cm.	4 weeks	−	
41	Rub. and 2% tincture iodine	0.001	10 c.cm.	4 days	−	No adhesions.
42	Rub. and 2% tincture iodine	0.001	10 c.cm.	6 days	−	
43	Rub. and Lugol solution	0.002	10 c.cm.	11 days	−	
44	Rub. and Lugol solution	0.002	10 c.cm.	1 week	−	Almost no adhesions.
45	Rub. and 2% tincture iodine	0.01	10 c.cm.	3 days	+	Slight congestion and adhesion at the area of application.
46	Rub. and 2% tincture iodine	0.01	10 c.cm.	10 days	+	
47	Rub. and 2% tincture iodine	0.1	10 c.cm.	5 days	+	Slight congestion and smelling and fibrous adhesion at the point of application.
48	Rub. and 2% tincture iodine		10 c.cm.	1 week	+	
49	Rub. and 2% tincture iodine	0.0005	20 c.cm.	3 weeks	−	Almost no adhesions.
50	Rub. and 2% tincture iodine	0.001	20 c.cm.	4 days	−	
51	Rub. and 2% tincture iodine	No preventive method used	—	4 days	+	Firm adhesions.
52	Rub. and 2% tincture iodine	0.001	10 c.cm.		−	Firm adhesions at anastomosis; no abnormal adhesion around.
53	Rub. and 2% tincture iodine	0.0005	10 c.cm.		−	
Dogs. 3	Rub. and 2% tincture iodine	0.0005	10 c.cm.	2 weeks	−	No adhesions.
4	Rub. and Lugol solution	0.001	10 c.cm.	2 weeks	−	

logical sodium chloride solution into the peritoneal connective tissue. By this method, he claims to have stimulated an excessive production of leucoprotease which, by its proteolytic effect, digested adhesions.

While this work may seem complicated and of uncertain value, it at least emphasizes the important effect of the digestive action of the proteolytic ferment protease.

In October, 1922, I was called to see Mrs. M. C., aged 33, 8 months pregnant with her first baby. She had full placenta prævia with a history of profuse hæmorrhage increasing in quantity for the last 3 weeks. An alarming secondary anæmia had developed and because of the refusal of the patient to submit to blood transfusion, a quick abdominal cæsarean operation was determined upon. It occurred to me on opening the abdomen that it would be valuable to transfuse intra-abdominally with blood which flowed during the operation. This necessitated a change in the old technique. Instead of keeping the uterus tight against the wound margin to prevent the spilling of uterine contents into the abdominal cavity, an effort was made to leave the blood in the pelvis. Much amniotic fluid was unavoidably mixed with it. The immediate and remote postoperative results were extremely satisfactory.

Later, I tried this method in cases in which there seemed little likelihood of infection for

TABLE IV.—ANALYSIS OF CÆSAREAN SECTION, SERIES OF 53 CASES; ABDOMEN FILLED WITH AMNIOTIC FLUID AND BLOOD

	Primary indication for cæsarean section	No. of operations	Adhesions seen at operation	Postoperative condition	Clinical peritonitis	Deaths
Primary laparotomy by writer	Contracted pelvis	21	None	Good	0	0
	Nephritis toxæmia	4	None	Good	0	0
	Previous extensive perineal repair	3	None	Good	0	0
	Placenta prævia, severe hæmorrhage	3	None	2 fair 1 sev. shock	0	0
	Previous cæsarean section	2	1 moderate 1 extensive	Good	0	0
	Disproportion	1	None	Good	0	0
	Ruptured uterus	1	None	Fair	0	0
	Total*	35			0	0
Re-openings	Contracted pelvis	16	3 slight 13 none	Good	0	0
	Nephritic toxæmia	0	0	0	0	0
	Previous extensive perineal repair	1	None	Good	0	0
	Placenta prævia, severe hæmorrhage	0	0	0	0	0
	Previous cæsarean section	0	0	0	0	0
	Disproportion	0	0	0	0	0
	Ruptured uterus	1	None	Poor	0	0
	Total †	18				

*One case showed firm adhesions between scar and omentum. The other case showed extensive matted adhesions between parietal peritoneum about scar, omentum, and anterior surface of uterus.

†Two cases showed a delicate strand of adhesions from lower border of omentum to abdominal scar. One case showed additional small strand to uterine scar.

the purpose of noting the postoperative effect. This was so uniformly and exceptionally good that I soon adopted the method as routine in all cases. I have collected a series of 53 abdominal cæsarean sections done by this method and present them for your inspection in table form (Fig. 4). In 18 of these a second operation was performed which gave me a chance to inspect the remote results of this new technique. Two cases are especially worthy of note, inasmuch as infection must have been present at the time of operation.

In one case the uterus had ruptured 24 hours before I was called to operate; in the other case, one of disproportion, several attempts had been made to deliver with instruments over a period of 6 hours. In these cases, this newly adopted technique was used and the abdomen closed around a small cigarette drain. In both, the drain was removed at the end of 48 hours and no primary or secondary peritonitis developed.

As to the origin and function of amniotic fluid, an extract from Williams (5) gives briefly the present attitude of authorities in this field of investigation.

"The biochemical investigations of Polano show that the amniotic fluid does not contain certain antibodies found in the maternal serum, which should be present were the former mere transudate; while the amniotic fluid and maternal serum lack a staphylolysin which is present in the fetal urine. Consequently, he concluded since the amniotic fluid was derived neither from the maternal serum nor from the fetal urine that the only origin possible must be a direct secretory action on the part of the amniotic epithelium.

"It (the amniotic fluid) also subserves an important function by preventing the formation of adhesions between the fetus and the walls of the amniotic sac which when they occur often give rise to serious deformities."

In order to gain further knowledge of the immediate action of amniotic fluid on the

TABLE V.—EFFECT OF *COW* AMNIOTIC FLUID ON GUINEA PIGS; INTRAPERITONEAL INJECTIONS; FLUID STERILIZED BY BERKEFELD FILTRATION

No.	Pig killed	Adhesions	Plastic exudate	No change
30	48 hrs.	o	x	
31	8 days	o	o	x

TABLE VI.—EFFECT OF BOILED AND UNBOILED HUMAN AMNIOTIC FLUID ON GUINEA PIGS; INTRAPERITONEAL INJECTIONS; PIGS KILLED AT 30 DAYS

No.	Fluid used	Firm adhesions	Moderate adhesions	Slight adhesions	Plastic exudate	No change
1	Boiled	o	o	o	o	x
2	Boiled	o	o	o	o	x
3	Unboiled	o	o	o	o	x
4	Unboiled	o	o	o	o	x
5	Unboiled	o	o	o	o	x

TABLE VII.—SERIES CONTROL ON STUDY OF FORMATION OF ADHESIONS IN GUINEA PIGS; PARIETAL PERITONEUM AND INTESTINAL LOOPS MARKEDLY EXCORIATED; NO AMNIOTIC FLUID USED

No.	Pig killed	Adhesions between gut and parietal peritoneum	Adhesions between loops of gut	Plastic exudate	No change
16	6 days	Many	Many	o	
12*					
13	12 days	Many dense fibrous	Dense fibrous; also gut to omentum	o	
14†	20 days	Numerous dense fibrous	Numerous dense	o	
15	20 days	Dense (3) Delicate (2)	Omentum to gut	o	

*Killed by other pigs on tenth day, and majority of viscera eaten.
†Sharp kink of bowel leading to partial obstruction.

TABLE VIII.—EFFECT OF AMNIOTIC FLUID ON FORMATION OF ADHESIONS IN GUINEA PIGS; PARIETAL PERITONEUM AND INTESTINAL LOOPS MARKEDLY EXCORIATED; FILTERED STERILE BOVINE FLUID (*BOILED*)

No.	Pig killed	Adhesions between gut and parietal peritoneum	Adhesions between loops of gut	Plastic exudate	No change
17	Died 6th day	Numerous fibrinous and delicate fibrous bands	None	+	
20	12 days	Moderate	Delicate (2)	o	
18	15 days	Moderate	Omentum to gut (1)	o	
19	15 days	Dense (1) Slight (2)	None	o	
21	15 days	Delicate (4)	Omentum to gut (1)	o	

TABLE IX.—EFFECT OF AMNIOTIC FLUID ON FORMATION OF ADHESIONS IN GUINEA PIGS; PARIETAL PERITONEUM AND INTESTINAL LOOPS MARKEDLY EXCORIATED; FILTERED STERILE BOVINE FLUID (UNBOILED)

No.	Pig killed	Adhesions between gut and parietal peritoneum	Adhesions between loops of gut	Plastic exudate	No change
7	6 days	Moderate	None	o	
11	12 days	Moderate	None	o	
8	20 days	Very slight	None	o	
9	20 days	Moderate	Slight adhesion of omentum to gut	o	
10	20 days	Moderate	None	o	

peritoneum, I resorted to a series of experiments on guinea pigs. The actual pathological work was carried out by Dr. Shields Warren of the Department of Pathology, Harvard Medical School. Because of the difficulty of obtaining human amniotic fluid uncontaminated with blood, we resorted to the use of cow fluid. Its effect upon the pigs was similar to that of the human fluid. Before using it in any human abdomens, Dr. Shields Warren, Dr. Warren Johnson, and the writer submitted to intradermal inoculation to determine the foreign protein reaction. This was negligible. The use of small quantities (20 cubic centimeters) in the abdomen of a small number of patients postoperatively showed no local or general reaction.

The experiments on the guinea pigs were divided into three general groups: first, those in which boiled amniotic fluid was used; second, those in which filtered unboiled amniotic fluid was used; and third, the control group in which no amniotic fluid was used. In addition to these experiments, minor experiments were performed to demonstrate: first, the presence or absence of complement; second

its value as a culture medium; third, its effect on human blood cells; and fourth, its injection intradermally to determine its foreign protein reaction. The results of the first three groups are best shown in table form (Tables V, VI, VII, VIII, and IX).

The results in the others showed *first*, amniotic fluid possesses a complement reaction equivalent to that of spinal fluid or ⅛ of that contained in normal pig serum; *second*, amniotic fluid unmixed with other substances shows a moderate growth in response to inoculation with streptococcus and pneumococcus; *third*, amniotic fluid mixed with equal quantities of human blood showed slight crenation of red blood cells after one hour, and slight hæmolysis at the end of 24 hours; *fourth*, the fluid injected intradermally in three human subjects, at the end of 24 hours showed a slight reaction and at the end of 48 hours had largely disappeared. At the end of 96 hours, there was nothing visible.

In the experiments conducted to determine the action of amniotic fluid on the formation of adhesions, I feel that our zeal in securing firm adhesions led us to be excessive in our technique. The method used for the production of adhesions was as follows: the abdomen of the pig was shaved, the animal was anæsthetized with ether and an incision made in the midline through the linea alba 2 centimeters in extent, beginning at a point about 1 centimeter below the ensiform cartilage. A number of loops of bowel, from 8 to 10, were exposed through the wound and rubbed briskly with sterile gauze until there was oozing of blood from their surfaces. These loops were left exposed for a period of about 5 minutes. During this time the abdominal wall was lifted up and the parietal peritoneum scraped thoroughly with a knife blade held at a right angle over an area centering at the incision about 4 centimeters in diameter. A considerable amount of red pulp on the knife bore evidence to the efficacy of this method in eroding the peritoneum. The abdomen was then sewed up with a continuous silk suture including muscle and peritoneum and with interrupted catgut sutures in the skin. The incision was then completely sealed over with collodion.

In the control pigs, nothing further was done. In the first series of pigs, 15 cubic centimeters of sterile Berkefeld filtered bovine amniotic fluid was injected into the peritoneal cavity at a point in the flank about 2½ centimeters from the line of incision. In the other series, the same procedure was followed substituting boiled amniotic fluid for the filtered sterile fluid.

When one considers the extreme erosion of the parietal peritoneum about the wound and the fact that the guinea pig's normal position following operation would bring the eroded gut in firm and constant contact with this surface, it is not to be wondered at that a certain number of adhesions were noted in every case at this point. It may also be noted that these adhesions occurred in the most pendent portion of the abdominal cavity. This would tend to rule out somewhat the theory that this fluid is effective by its mechanical presence. Fair conclusions in this series of experiments can be drawn only from the number and extent of the adhesions present between the loops of gut and the omentum, as indicated in the tables.

In considering the method of action of this fluid in preventing postoperative peritonitis and abdominal adhesions, it is apparent from the pig experiments that its presence within the peritoneal cavity has the effect of immediately stimulating the laying down of a thin layer of fibrin on the peritoneal surface and the production of a moderate leucocytosis. The fibrin serves as a protection against the absorption of toxins and the spread of infection. The action of the leucocytes is to attack infection and produce the proteolytic ferment protease which results in the resolution of the protective layer of fibrin after need for its existence has passed and before it has become organized into firm connective tissue.

The action of the fluid is an exact imitation of the primary reaction of nature to peritoneal inflammation in the case of infection or trauma. The advantage is that this reaction is produced immediately, before any possible infective agent has had a chance to pass the stage of incubation and attack the peritoneum in force. Whether the action of

this foreign substance is due to its chemical constituents or the presence of an enzyme or a combination of both is yet to be determined.

In favor of the chemical action is the following paragraph taken from McCallum (3): "Many ideas have been expressed as to the reason for the passage of the leucocytes through the wall, but it seems that the weight of evidence is in favor of their active penetration between the cells in response to the attraction of some diffusible soluble substance which is either the injurious agent itself or produced by its destructive action on the cells of the tissue. It is so evident that dead tissue killed by any mechanical means or by being deprived of its blood supply, as in the case of an infarction, can act in this way to attract the leucocytes, that in every case it must play a part. Experimentally it has been shown that extracts of dead cells are positively chemiotactic. Nevertheless, the leucocytes appear in so much greater number when bacteria or some chemical irritant causes the inflammation that unquestionably these poisonous substances themselves have a powerful influence."

Supporting the enzyme theory, we have the fact that one of the chief functions of amniotic fluid is the prevention of adhesions between the amniotic membrane and the fetus; also the fact that in the experiments on laboratory animals, the boiled fluid did not produce as good results as the unboiled fluid sterilized by passing through the Berkefeld filter.

In using this fluid in the human abdomen, the same method of sterilization is used as in the laboratory. Whether subsequent experiments in which concentrated, desiccated, or chemically altered amniotic fluid is used will prove this altered fluid of greater benefit in the prevention of postoperative peritonitis and abdominal adhesions will be determined by further experimentation and reported upon in a supplementary paper.

SUMMARY

1. Amniotic fluid is a logical substance to employ for the prevention of adhesions since one of its chief functions in its natural location is the prevention of adhesions between the amniotic sac and the fetus.

2. This fluid sterilized by the Berkefeld filter method is safe to use postoperatively in the abdominal cavity.

3. Its action in the peritoneal cavity is the immediate production of a protective layer of fibrin on the peritoneal surfaces and a moderate local leucocytosis followed later by complete resolution of the fibrinous deposit leaving no permanent injury to the serous surface.

4. Its method of preventing peritonitis is its quick effect in setting up a fibrinous wall of defense together with the stimulation of a moderate local leucocytosis. Its apparent method of preventing adhesions is by stimulating rapid resolution of the plastic exudate through the action of proteolytic ferments which in turn are due to the local leucocytosis.

5. Laboratory and clinical observations have proven beyond any reasonable doubt that the presence of this fluid postoperatively in the abdominal cavity exercises a distinct beneficial effect against the development of peritonitis and the formation of adhesions without deleterious effect.

6. The subject matter of this paper covers clinical and laboratory observations far too small in scope to act as a basis for final conclusion but large enough to justify a preliminary report on the work in hand. To this extent only is this paper offered as a scientific contribution.

REFERENCES

1. Deaver, John B. Intra-abdominal adhesions. Surg., Gynec. & Obst., 1923, xxxvii, 506.
2. Kubota, Takashi. The prevention of peritoneal adhesions. Japan M. World, 1922, xi, 226.
3. McCallum, O. A Textbook of Pathology, pp. 145 and 146. Philadelphia: W. B. Saunders Co.
4. Naumann, H. Biological treatment of adhesions. Arch. f. klin. Chir., 1925, cxxxiv, 1.
5. Williams. Obstetricii. Appleton, 1921, p. 166.

ACUTE APPENDICITIS COMPLICATING PREGNANCY, LABOR, AND THE PUERPERIUM

By ROBERT A. WILSON, M.D., Brooklyn
From the Department of Obstetrics of the Methodist Episcopal Hospital, Brooklyn, N. Y.

THE writer will first report ten cases of pregnancy complicated by appendicitis, treated in the obstetrical and surgical services of the Methodist Episcopal Hospital since 1915. Following this the frequency, etiology, symptomatology, diagnosis, and prognosis will be taken up in order and the paper concluded by a detailed survey of the question of treatment.

Very few cases of acute appendicitis occurring in the last dimester of pregnancy have been reported. DeLee has reported four, Wallace one, and Grattan one. To these I add my case (Case 10).

Case 1. M. S., age 22, white, iii-para, was admitted to the Methodist Episcopal Hospital November 18, 1922. (Service of Dr. T. B. Spence.) At the time of admittance this patient was 7 months pregnant. Her history showed that for several years she had suffered from intermittent attacks of lower abdominal pain, digestive disturbances and vomiting. Her entry in the hospital was occasioned by a sudden attack of pain in the lower abdomen, nausea, repeated vomiting, and a slight chill. Abdominal palpation revealed typical signs of acute appendicitis. The leucocyte count was slightly increased and the urine negative. A prompt operation within 12 hours of the onset of pain was performed. The appendix was found acutely inflamed but not ruptured. After appendectomy with inversion of the stump, the abdomen was closed without drainage. Convalescence was uninterrupted and although uterine contractions occurred, they were easily controlled by morphine and the gestation progressed to term.

Case 2. E. D., age 34, white, ii-para, entered the Methodist Episcopal Hospital December 21, 1922. (Service of Dr. R. A. Wilson.) This patient's history showed that an acute attack of appendicitis had occurred 4 years before admission to the hospital and had spontaneously subsided. There had been no trouble in the interval. When 2 months pregnant, severe abdominal pain with nausea and repeated vomiting occurred. The diagnosis was not difficult, typical signs of appendicitis being present. The leucocyte count was 20,000 with a polymorphonuclear ratio of 80 per cent. The urine findings were negative. In less than 8 hours from the commencement of the attack, the abdomen was opened by means of a right rectus incision. Appendectomy and inversion of the stump were performed for an acute suppurative condition without rupture and the wound closed without drainage. An uneventful recovery followed, and the pregnancy went to term.

Case 3. M. W., age 20, white, i-para, entered the Methodist Episcopal Hospital June 8, 1924. (Service of Dr. G. H. Davis.) In this case there was a history of severe digestive disturbances for many years, but no pain. When 6½ months pregnant, an attack of abdominal cramp-like pain developed suddenly, accompanied by nausea and repeated vomiting. She was treated at home for 3 days by the family physician who believed the trouble to be salpingitis, but as she became progressively worse and vomited incessantly she was then sent to the hospital. The blood count at this time showed 24,000 leucocytes with 90 per cent polymorphonuclears. A diagnosis of appendicitis was made and immediate operation advised. A right rectus incision was used and a gangrenous and perforated appendix removed. A widespread peritonitis existed. A rubber tube to the pelvis and a cigarette drain to the abscess site were used for drainage. The patient's condtion became progressively worse and she died 5 days later, despite every effort to save her life. Uterine contractions did not occur at any time.

Case 4. S. D., age 22, white, ii-para, entered the Methodist Episcopal Hospital October 11, 1924. (Service of Dr. Russell S. Fowler.) Her history disclosed that she had suffered from a great deal of "stomach trouble" for many years, with occasional attacks of abdominal pain, the latter having been diagnosed upon two occasions as appendicitis. When 4 months pregnant, another attack occurred much more severe than any previously experienced and well localized in the right lower quadrant. The blood count remained normal, but because of the physical signs immediate operation was performed about 12 hours from the commencement of the attack. A McBurney incision was used and an acutely inflamed appendix found, but rupture had not yet taken place. The organ was removed and the stump inverted. An uneventful recovery followed, the pregnancy remaining undisturbed.

Case 5. D. G., age 29, white, i-para, entered the Methodist Episcopal Hospital September 6, 1925. (Service of Dr. G. H. Davis.) In this instance the history was entirely negative and the attack apparently a primary one. When 3 months pregnant severe sudden abdominal pain occurred, rapidly localizing in the right lower quadrant. She vomited several times. The blood count was normal, the physical signs were typical and operation was per-

formed at once, although about 30 hours had elapsed since the commencement of the attack. The incision was made through the right rectus muscle and a localized peritonitis indicated that perforation was present. After the removal of a ruptured appendix, drainage was secured by the use of a split rubber tube to the infected site. Despite the use of large doses of morphine, the patient miscarried 5 days later. Following this her convalescence was uneventful and she made a perfect recovery.

CASE 6. J. P., age 21, white, ii-para, entered the Methodist Episcopal Hospital April 11, 1924. (Service of Dr. R. M. Beach.) Her history disclosed considerable gastric distress for years, with occasional vague right sided pain. A sudden attack of lower abdominal cramps with two spells of vomiting caused her to enter the hospital. After a careful examination, a tentative diagnosis of right ectopic gestation was made because of the pelvic findings and a suggestive history. The possibility of appendicitis was also borne in mind, however. Leucocytes were 11,000, polymorphonuclears 78 per cent, and the red count normal. Operation by means of a mid-line incision within 20 hours of the onset of the pain, revealed a gangrenous perforated appendix with considerable peritonitis. In the uterus was a pregnancy of about 6 weeks' duration. Appendectomy was performed and drainage instituted by means of a rubber tube to the pelvis and a cigarette drain to the infected area. An excellent recovery ensued with no disturbance of the pregnancy.

CASE 7. F. H., age 28, white, i-para, entered the Methodist Episcopal Hospital December 16, 1924. (Service of Dr. O. P. Humpstone.) At the time of entry she was three and a half months pregnant with a history of many attacks of abdominal pain, nausea, and vomiting, for the last 2 years, repeatedly diagnosed as appendicitis. From the beginning of this pregnancy, these had become more frequent and severe. The appendix was removed through a right rectus incision and found to be kinked, thickened, and injected. No disturbance of the ovum followed, her symptoms were immediately relieved and they have not since returned.

CASE 8. E. H., age 32, white, iii-para, entered the Methodist Episcopal Hospital March 27, 1925. (Service of Dr. T. B. Spence.) This patient had a definite history of chronic appendicitis for the last 4 years, with constant pain and frequent nausea and vomiting. The symptoms had become much worse during the pregnancy which was of 3 months' duration. The removal of a diseased appendix was followed by an uneventful convalescence and complete relief of symptoms.

CASE 9. V. S., age 23, white, ii-para, entered the Methodist Episcopal Hospital December 12, 1926. (Service of Dr. R. A. Wilson.) For the last year frequent attacks of low grade appendicitis had occurred at irregular intervals, becoming more frequent and severe during her pregnancy which was near the end of the fifth month. The appendix was removed by means of a right rectus incision and found to be retrocæcal, kinked and clubbed. An excellent recovery followed with a total absence of uterine contractions.

An analysis of the nine cases just reported reveals certain points of interest, namely:

1. In the six acute cases only one of the attacks was primary. In all the others a history of a pathological appendix was obtainable.

2. Pregnancy had an injurious effect in the 8 cases in which a diseased appendix existed. Marked exacerbation of symptoms occurred.

3. In the presence of a pregnancy, perforation and peritonitis appeared rapidly. Prompt diagnosis and operation gave the best results.

4. Of the three perforated cases, one died. If operated upon before perforation, however, recovery was rapid and without complication.

5. Only 1 case miscarried despite the fact that 3 of them required drainage.

6. The last 3 cases show operation performed largely as a prophylactic measure, with excellent results and no disturbance of the fetus.

Case 10 is reported in detail because of its rarity, the difficult diagnostic problem it presented and the method of treatment which was followed.

CASE 10. N. L., age 26, white, i-para, consulted the writer March 15, 1925, when 3 months pregnant. Her history was negative with one important exception. In 1923, she had had a sudden attack of right sided pain and severe nausea, which had been diagnosed by her family physician and a surgical consultant as pyelitis. In view of later events, however, this diagnosis might well be doubted and careful questioning made it appear most probable that the attack was appendicitis. She had made a good recovery, however, without further symptoms. When first seen in the office the patient was in excellent health, her physical examination being entirely negative, the uterus in good position and about the size of a 3 months' pregnancy; blood pressure 110—65; urine negative. She was also examined on several occasions afterward and no pathological condition found.

On August 24, 1925, her pregnancy being then of about 8½ months' duration, an urgent call was received to see her at home. She was found in bed, evidently in great pain and having hard, regular, contractions of the uterus. As labor appeared to be

in progress, ¼ grain of morphine was administered and immediate removal to the hospital advised. She was admitted to the Methodist Episcopal Hospital August 24, 1925, at 5.00 p. m. and until operation was finally performed presented a problem of great interest.

Examination upon admittance showed her to be having painful uterine contractions every 2 minutes. There was some tenderness over the entire abdomen most marked in the right lower quadrant. No fetal heart could be heard. Vaginal examination disclosed a softened and somewhat thinned out cervix, but no dilatation. A blood count at this time showed 20,000 leucocytes with 87 per cent polymorphonuclears. In view of the previous history, a diagnosis of pyelitis with premature labor was made and suitable treatment instituted. A catheterized urine examination made a few hours later proved to be entirely negative and the diagnosis became questionable.

The next morning her general condition was worse, the pain more severe, but uterine contractions had stopped. The uterus was now definitely tense and quite tender. A surgical consultant after a careful survey stated that he could not make a definite diagnosis, but in view of the blood count and the negative urine findings considered appendicitis a strong probability.

An obstetrical consultant about the same time, however, made a probable diagnosis of accidental hæmorrhage of the concealed variety, basing this diagnosis on the generalized tenderness of the uterus, its increased tension, and the absence of a fetal heart.

The patient was now very pale with a red cell count of 3,000,000, hæmoglobin 65 per cent. The surgical consultant again examined the case and stated that in view of the marked uterine tension, tenderness, and apparent fetal death, with a definite anæmia, intra-uterine difficulty was the most probable diagnosis.

In the next few hours additional laboratory work was done, which resulted in the definite ruling out of pyelitis and made the diagnosis rest between accidental hæmorrhage and acute-appendicitis.

A third consultant was now called in. After a most careful examination and consideration of all the facts he expressed the following opinion: "While many of the signs are not clear, I consider this a case of accidental hæmorrhage. Appendicitis cannot, however, be ruled out definitely until the abdomen is opened. I advise immediate exploration."

As the patient's condition was growing worse she was prepared for operation, which was performed during the evening of her second day in the hospital. During this time no nausea or vomiting had been present.

Operation. An ample right rectus incision was used. The uterus was a little mottled in appearance, but clearly did not contain much if any free blood. It was protected with lap sponges and the region of the appendix carefully approached. Some flakes of fibrin and marked congestion and œdema were noticed. Exploration went no further for the time being. The uterus was quickly emptied, through the classical incision and a living baby extracted, which appeared toxic, however, was difficult to resuscitate and died a few hours later. The incision was closed in three layers by continuous sutures. With the uterine wound well protected, the appendicular region was again approached and a pool of foul yellow pus welled forth. A long thick, gangrenous appendix with a large perforation at its base was next brought into view. It was removed and the stump purse-stringed with some difficulty because of the extensive œdema of the cæcum. A split rubber tube to the pelvis and a cigarette drain to the abscess site were used for drainage and the abdomen closed.

A severe lower abdominal peritonitis developed, and for the next 4 days her condition was serious, but on the fifth day a decided improvement took place. After this her convalescence was satisfactory, the cigarette drain being removed on the tenth day and the tube progressively shortened and finally removed on the twenty-second day. Thirty-five days following operation she left the hospital with the wound completely healed. The lochia was at all times normal in quantity and character and apparently no infection of the uterine wound occurred. Since operation she has enjoyed excellent health and at this date (January 1, 1927) is pregnant again, being now in her sixth month.

In considering the appendix in women, we would do well to remember that in many patients it is a pelvic organ, often in close proximity to the right adnexa and therefore easily involved if pelvic pathology exists. The appendiculo-ovarian ligament contains lymphatics draining from the right adnexa and also in many cases a small branch of the ovarian artery (appendiculo-ovarian). A decidual reaction in the appendix has been observed, and recently certain writers have reported the presence of endometrial implants. We can thus readily see that it can be damaged by pelvic pathology, or itself involve the pelvic organs.

Let us attempt to visualize what is occurring in the abdomen during pregnancy. As the uterus progressively enlarges, it presses upon the cæcum and along with the appendix it is pushed upward and to the right. The omentum is also carried into the upper abdomen and cannot easily return. Sudden inflammation occurring during this time does not have the aid of the omentum or intestines to help in the localization of the process and the

uterus frequently becomes one of the limiting organs, but at the risk of being itself intimately involved. It is only by a realization of these factors and of the pathological changes next to be discussed that the rationale for the treatment of acute attacks of appendicitis occurring in the last trimester of pregnancy can be understood and defended if necessary.

As the pregnancy progresses, the cæcum and appendix are subject to increasing pressure, if free, and marked traction if adhesions are present, so that existing kinks are made worse and bands further tightened. It is thus easy to see how intestinal emptying is interfered with and old lesions irritated and activated.

If an attack should occur particularly in the late months, it is likely to be rapid and virulent in its course. The congestion and numerous large vessels present probably largely explain this, so that only a comparatively short time elapses before perforation occurs in the great majority of cases. Localization of the process is poor or does not take place at all. There is no omentum and little if any small intestine to wall off the inflammation and the lateral uterine wall is directly involved. A marked reaction occurs resulting in an injected and sometimes œdematous metritis. Contractions of the uterus follow in nearly all cases and markedly aggravate the inflammation and aid the spreading of pus, which easily finds its way to the upper abdomen.

When an abscess is present, the uterus is often part of its limiting wall and a sudden emptying of the uterine contents is likely to tear open the abscess and allow the pus to flow freely where it will. A few cases have been reported in which an appendicular abscess has burrowed and ruptured into the uterus, vagina, bladder, or rectum. In most cases, however, the tendency to spread is in the direction of the upper abdomen.

So that it can be stated that the problem is more difficult and complex than that encountered in the non-pregnant woman.

FREQUENCY

Primary acute appendicitis does not occur more frequently in the pregnant than in the non-pregnant woman and the cases reported of this type are few. Case 5 does fall in this classification. There is no doubt, however, that pregnancy reacts unfavorably if the appendix has been the seat of previous trouble and aggravates the condition to a marked extent. Women in the early months of pregnancy often complain of such a number and variety of troubles that there is a general tendency to gloss over and ignore many of them. It is now becoming realized that many of the digestive symptoms and much of the abdominal pain and discomfort are undoubtedly due to the appendix.

Findley, in 1912, reported 15 cases of appendicitis complicating pregnancy in which 14 had suffered from previous attacks. He further stated that at least 70 per cent of those women who have had appendicitis prior to gestation will suffer more or less from this cause during a subsequent pregnancy. Felkner some time ago made a report concerning observations on 3,800 cases of pregnancy. He stated that a return of appendicitis was observed to take place in all the cases in which it was previously known to have existed, with but one exception. It can be safely stated that pregnancy and a previously diseased appendix are not compatible.

This complication occurs most frequently between the third and sixth months, less frequently in the first three and only rarely in the last trimester. Donahue definitely states that 80 per cent of all cases occur in the first 6 months.

In considering the puerperium, we find that no figures are available. It is easy to understand however, how often this condition might be present and yet be overlooked. It would be well to bear in mind that not all temperature, pain, tenderness, and rigidity at this time are due to puerperal infection. The appendix should be investigated as well as our attention directed to the possibility of other disease, such as degenerating fibroids, a twisted ovarian cyst, etc.

It occurs with equal frequency at all ages during the childbearing period. It is found in multiple as well as single pregnancies, also with extra-uterine as well as intrauterine gestations. While accurate figures are

difficult to obtain, the best available show that of all women having acute appendicitis, about 2 per cent of them are pregnant.

ETIOLOGY

Attacks of primary acute inflammation during pregnancy are occasionally seen, but they are certainly not more frequent than at any other time or condition of life. If a careful history is taken, practically every case will present evidence of previous trouble in the appendix with a resulting exacerbation if a pregnancy supervenes.

The organisms usually encountered are the streptococcus, staphlococcus, colon bacillus and sometimes the Welch bacillus. They play the same part here as in appendicitis at other times.

All pathological types are found, the most frequent being the catarrhal, suppurative, ulcerative, gangrenous, and perforative. The latter is at once followed by peritonitis and other complications.

SYMPTOMATOLOGY

The symptoms of appendicitis are so well known that little time will be devoted to them. It would be well to point out however, that, while quite typical in early pregnancy, they are likely to be obscure, misleading, or masked in the later months. Abdominal pain, nausea, vomiting and a late rise in temperature occur as might be expected and sometimes a marked irritability of the bladder and rectum is present. The symptoms are those we associate with appendicitis, but often atypical and difficult to elicit and interpret.

DIAGNOSIS

As a rule diagnosis is easy in the early months but becomes increasingly difficult as term approaches. In the last few months it is always troublesome, is practically impossible during labor, and is also likely to be difficult in the puerperium.

A rather common mistake is to confuse an early right-sided ectopic gestation with appendicitis, or vice-versa. This occurred in Case 6. Happily as operation is usually required in either case, the consequences are not likely to be serious, if the procedure is not too long delayed.

Another mistake at any period of gestation is to consider the attack one of pyelitis. The result may be disastrous. The opposite mistake with the removal of a normal appendix is certainly the preferable of the two.

A most confusing factor will now be mentioned. Soon after the onset of an attack, the sensitive uterus frequently responds to the irritation produced by neighboring inflammation, by commencing to contract. The result of these contractions is to cause the attendant to consider the patient in labor and much valuable time may be lost before it becomes evident that all is not well. Even vomiting and a rise of temperature may not appear particularly significant at this time. This largely explains why an attack commencing during labor is practically never recognized.

In attempting to make a diagnosis, every aid should be employed and of these the most important is a history of previous attacks. In view of the rarity of primary acute appendicitis during pregnancy, this cannot be emphasized too strongly. If we then consider carefully the symptoms, also whatever physical signs are present, and supplement this by a pelvic touch and urine examination, we have done about all that is possible.

Much of the aid usually obtained from a blood count is unavailable because of the leucocytosis which normally exists during pregnancy. If the count is well above 12,000, however, and the polymorphonuclear ratio is markedly increased, we have something of definite diagnostic value.

The last important point is to exclude as far as possible other sources of trouble.

The following conditions are the ones most frequently to be considered in making a differential diagnosis: (1) gall-bladder disease, (2) right-sided ectopic pregnancy, (3) right-sided pyelitis or renal colic, (4) ovarian cyst with a twisted pedicle, (5) degenerating fibroid tumors, (6) intestinal obstruction; and more rarely, (7) diverticulitis and (8) mesenteric thrombosis.

PROGNOSIS

Acute appendicitis has a higher morbidity and a greater mortality in the presence of a pregnancy than at other times, the prognosis largely depending on the rapidity with which a diagnosis is made and operation performed. As Babler has so aptly stated, "The mortality of appendicitis complicating pregnancy is the mortality of delay." The mortality at any period of pregnancy is practically nil if operation is performed upon an unruptured appendix, but, once perforation has taken place, it is about 40 per cent for the first 6 months and in the neighborhood of 60 per cent for the last 3. If abortion should occur, the rate will be at least 10 per cent higher in each instance. Fairbairn quoted a series of 74 perforated cases, with 50 deaths, under various methods of treatment. Schmidt reported 486 perforated cases with a mortality rate of 50 per cent. So that we are undoubtedly dealing with one of the most dangerous complications of pregnancy.

When we consider the fetus it is evident that if an early operation is done, abortion will seldom take place. In the 9 cases previously reported this occurred in only one instance, and Myers sometime ago also reported 17 cases without disturbance of the ovum. Other writers have reported numerous similar instances. Once perforation is present, however, about 40 per cent of the pregnancies in the first 6 months will be lost, and the outlook is much darker in the last trimester. Perforation during the latter period will give a premature labor ratio of at least 90 per cent, only a rare case going to term if the mother is fortunate enough to survive. The writer believes that this last point is important to bear in mind, for he bases the treatment of these late perforated cases very largely on the fact that the woman will miscarry if the child is left in the uterus.

PROPHYLAXIS

Before taking up the most interesting phase of this subject, namely treatment, let us stop for a moment to consider if anything can be done to prevent the occurrence of this serious complication of pregnancy. It is with this in mind that the following recommendations are made:

1. The routine removal of the appendix, even when it appears normal, should be done during laparotomies performed for other conditions, whenever it is safe and practical to do so.

2. If a married woman has a diseased appendix, the offending organ should be removed before she becomes pregnant.

3. A pregnant woman with a history of previous trouble in the appendix should have appendectomy performed at the first appearance of symptomatology. The attending obstetrician during this period of observation should be ever on his guard in expectation of an acute attack.

TREATMENT

Although the treatment is always surgical, it differs markedly during various periods of gestation, so that it is best to consider each of these periods separately.

Treatment during the first six months. The operative procedure here does not differ essentially from that employed when a pregnancy is not present, as the uterus is not yet of sufficient size to interfere with access and drainage. Careful handling of the uterus is necessary and the modern tendency to avoid drainage whenever possible is highly desirable. Following operation, the patient should be deeply morphinized for several days. A right rectus incision gives good access, and the appendix should always be removed if practicable. If the condition of the patient is poor, drainage of an abscess if present may be all that can be done at the time, and, in such an instance, a secondary operation for the removal of the appendix may be necessary later. This should be postponed until considerable time has elapsed following delivery unless marked symptoms compel earlier intervention.

Treatment during the seventh month. At this period the conditions encountered determine the treatment to be used, and the judgment of the operator is all important. The size of the uterus, the position and accessibility of the appendix, the amount of pathology, must singly and collectively be

considered. As a rule, the treatment is similar to the one just outlined, although in certain cases, because of the aforementioned conditions, the procedure must be that reserved for the last 2 months.

Treatment during the eighth and ninth months. Until now the question has been largely a surgical one, but at this time the obstetrical management of the case confronts us and several problems arise. The most important of these will be briefly discussed:

1. Should the pregnancy be terminated or left undisturbed? In discussing this problem it is well to recall that perforation and some degree of peritonitis are likely to be present when the abdomen is opened. If this is fortunately not so, only one procedure is warranted, namely, to remove the appendix quickly and leave the pregnancy alone. In this type of case if premature labor ensues, no harm will result provided the abdomen has been securely closed. With perforation and peritonitis present, however, the pregnancy can rarely be saved and labor will follow operation within a few days, with disastrous results. Newly formed adhesions will be torn, drains displaced, pus widely spread and a sick patient further exhausted. It would be well to bear in mind also that the baby is toxic and, if delivered at the time of operation, is spared further toxæmia and the punishment of labor.

The answer to this first question is, that in the presence of perforation, the uterus should be emptied at the time of operation in the interest of both mother and child.

2. If termination of the pregnancy is decided upon should it be done from above or below? This question concerning the relative merits of supravaginal versus infravaginal delivery is not a difficult one. Three methods to accomplish the latter are available, namely, vaginal cæsarian section, accouchement forcé and induction of labor by the use of bags, bougies, etc. It is generally conceded today that vaginal cæsarean section should seldom be done after the commencement of the eighth month, for the technical difficulties are too great and the baby almost always is lost. The most important objection to this procedure in the present instance, however, is based on the fact that it inflicts a shocking, bloody operation which must at once be followed by an abdominal one; either alone being considered sufficiently severe for a patient to withstand. Accouchement forcé has the same objection to a more marked degree and is now considered an obsolete procedure. The induction of labor by any method would not be indicated, as this would mean more or less delay, which is never permissible.

It is evident that none of the aforementioned methods can be used and that delivery must be accomplished from above.

3. What types of operation are available to open the uterus and what are the indications for each? If a marked peritonitis is present, with extensive involvement of the uterine wall, a rapid Porro operation is the safest procedure, offering the best chance for free drainage, the complete removal of infected tissue and ultimate hope of recovery.

The two flap, low section must be considered whenever the uterine wall is involved, provided the involvement is not too extensive and other conditions are suitable for its use. Unfortunately, this is not often the case, as there has seldom been sufficient labor to thin out the lower uterine segment and draw up the bladder. This method ranks next to the Porro operation for safety whenever it can be properly performed.

The classical section, because of its simplicity, is the method best adapted to most cases and, unless performed in the presence of severe infection, will yield good results. Whenever this procedure is used, it is advisable to close the uterus in layers and to peritonealize the incision as much as possible.

The writer suggests the following procedure at time of operation:

The abdomen should be opened by a liberal incision and, unless definite evidence of the trouble is apparent, the appendix site should be carefully approached, during which time the uterus is protected by lap sponges. If an inflamed but as yet unruptured organ is encountered, it should be removed and the abdomen securely closed. At the first appearance of peritoneal involvement, however, further exploration should at once be stopped and the diseased area

carefully isolated with sponges, the operator's gloves changed, and all made ready to empty the uterus. If the peritonitis is extensive, with marked involvement of the uterine wall, the Porro operation should be performed. If the infection is less severe, the low cæsarean section is indicated provided other conditions permit. In the other cases, in which only slight uterine wall involvement exists, or is entirely absent, the classical operation should be done.

Following delivery the uterus, if it has not been removed, should be again protected and the appendix dealt with. The operation should be a rapid one and every effort made to avoid the spreading of infection, as these two factors play an important rôle in the prognosis.

When drainage is necessary, it is essential that it be thorough. As a rule it is better not to use the abdominal incision for this purpose but to employ a stab wound in the right flank. Vaginal drainage is very satisfactory, particularly in conjunction with the above and should always be used after a Porro operation.

Treatment during labor. The possibility that it may become necessary to treat this condition, at this time, is slight because the diagnosis is made with difficulty, and in but few cases, so that little space will be devoted to treatment during labor. Treatment is essentially the same as that just outlined for the last dimester. If, however, examination shows delivery to be imminent, the birth must of necessity be from below. Following this we should not delay in performing a laparotomy, bearing in mind that the violent excursions of the uterus in all probability have caused the infection to become widespread.

Treatment during the puerperium. Appendicitis in the puerperium frequently is not diagnosed, but whenever operation is done, the technique of appendectomy as performed at other times is used. The writer believes that the following case is a good illustration.

M. L., age 38, ii, entered the Methodist Episcopal Hospital February 5, 1927. Her history was negative except for occasional nausea and belching of gas without apparent cause. After an uneventful confinement she was returned to bed in good condition. The day following delivery she vomited several times and complained of considerable abdominal pain which became worse during the next 5 days and was fairly well localized in the right lower quadrant. Because of the presence of pus cells in the urine and some tenderness along the course of the ureter, the patient was treated for pyelitis. During this 5 day period the leucocytes remained at 12,000 with 83 per cent polymorphonuclears. A consultation was held at the end of the fifth day as the patient was getting worse. This disclosed the presence of an indefinite mass near McBurney's point and, because of this and an increase of leucocytes to 16,600, polymorphonuclears 89 per cent, a final diagnosis of acute appendicitis was made. Immediate operation revealed a large abscess and a gangrenous, ruptured appendix with a hole at its base. After the appendix was removed, the abdomen was freely drained. The patient did well for 3 days, when she died suddenly of a pulmonary embolus.

COMPLICATIONS

Complications occur to an extent which might be expected, but they are not more varied or more severe than those found after other cases of appendicitis. One exception to this, however, is that the incidence of pelvic phlebitis is much increased. The cause of death in Case 10 was an embolus probably originating from a pelvic phlebitis.

CONCLUSIONS

1. No reliable statistics are available to indicate how frequently appendicitis complicates pregnancy. It is known, however, that about 2 per cent of women with acute appendicitis are pregnant.

2. About 80 per cent of the cases occur in the first 6 months, the disease being comparatively rare in the last dimester. It undoubtedly is more common in the puerperium than is generally supposed, but is frequently overlooked at this time.

3. Pregnancy reacts unfavorably on a diseased appendix. It always aggravates the existing pathology and is likely to precipitate an acute attack at any time. Primary attacks during pregnancy are quite rare.

4. The disease runs a rapid course, and perforation and peritonitis may be present in a few hours. This is especially true in the late months of pregnancy.

5. The diagnosis becomes increasingly difficult after the sixth month, this being especially true if uterine contractions are present. The leucocyte count does not furnish much aid because of the leucocytosis normally existing during pregnancy. In case of doubt, operation should be performed.

6. The maternal prognosis is good if an early operation is performed, but following perforation a mortality rate of 50 per cent is to be expected. In simple cases there is little danger of abortion, but if perforation is present, the uterus will empty itself in at least 50 per cent of the cases. The more advanced the pregnancy the greater is the danger to mother and child.

7. Whenever possible, the appendix should be removed during laparotomies performed for other conditions. When the organ is known to be diseased, it should be removed before pregnancy occurs and, if a pregnancy is already present, at the first appearance of symptoms.

8. It is in the last dimester that several important problems have to be dealt with, and it is in order to meet these that cæsarean section, followed by appendectomy, is advocated as the procedure which will give the best results.

9. The method to employ in emptying the uterus depends on the extent to which the uterine wall is involved in the infectious process. When this is slight, the classical operation is indicated, but, if severe, a choice must be made between a low section or the Porro operation.

BIBLIOGRAPHY

ANDERSON, A. W. Nebraska M. J., 1923, viii, 102-124.
BUFORD, R. K. West Virginia M. J., 1921, xv, 335.
BUNCH, G. H. J. S. Carolina M. Ass., 1918, xiv, 250.
COCKE, N. P., and MASON, J. M. J. Am. M. Ass., 1920, lxxv, 95.
DAVIS, E. P. Complications of pregnancy. Obst. and Gynec. Mon., 1923, p. 154.
DAVIS, E. P. Prog. Med., 1924, iii, 34-37.
DAWES, L. P. Illinois M. J., 1918, xxxiii, 171.
DELEE, J. B. Surg. Clin. N. Am., 1921, i, 100-3-1-12.
Idem. Principles and Practice of Obstetrics 1924.
DOYLE, FRANCIS B. Am. J. Obst., 1916, lxxiv, 849.
DUBOIS, C. F. J. Michigan M. Soc., 1923, xxii, 244-247.
FAVERAU, M., and CHAPUT L. Prog. Med., 1923, xxxviii, 133-135.
FINCKLEN, E. A. New Orleans M. & S. J., 1925, lxxviii, 146-152.
FINDLEY, P. J. Am. M. Ass., 1912, lix, 612.
GORE, V. M. Southwest M. J., 1924, viii, 383-389.
GRATTAN, J. F. Surg., Gynec. & Obst., 1919, xxix, 457.
HEINECK, A. P. West Virginia M. J., 1917, xii, 127.
Ibid., 1919, xiii, 292.
HERMANS, A. G. J. Nederl. Tijdschr. V. Geneesk., 1924, ii, 1004-1017.
HIRST, B. C. A Textbook of Obstetrics, 1924.
JENNINGS, CHARLES L. J. Florida M. Ass., 1916, iii, 82.
MCLEAN, J. H. Texas St. J. M., 1915, xii, 296.
PRIBRAN, E. E. Klin. Wchnschr., 1922, i, 125-1268.
SEXTON, M. C. Indianapolis M. J., 1921, xxiv, 302.
TATE, L. A. Lancet, 1916, cxv, 133.
TRACY, STEPHEN E. Pennsylvania M. J., 1916, xix, 826.
WALLACE, C. J. J. Am. M. Ass., 1915, lxiv, 737.
WILLIAMS, J. W. Obstetrics, p. 571.

DIVERTICULUM OF THE URINARY BLADDER

By WINFIELD S. PUGH, B.S., M.D., New York

DIVERTICULA of the bladder have long been recognized at autopsy, as shown in the writings of Albucasis (1) in the eleventh century, of Blasius (3) in 1677, and particularly of Morgagni in 1769. The very early writers designate them not as diverticula, but as supernumerary bladders. This is noted in the writings of Brussiere, who mentions examples of double and triple bladder. Lambratti, Fannoni, and Malgetti allude to a four sac bladder. We believe Morgagni (21) was the first one to place diverticula on an anatomicopathological basis and to designate them diverticula. Herbst (11) and others credit this early work to Heister.

While the history of diverticula is a fairly long one from the archives of the pathologist, as a clinical entity it is really very brief. In fact one may unquestionably say that before the introduction of the cystoscope by Nitze their recognition was rare. In fact they were detected only when of such size as to project above the pubis. This also was mostly guess work. More often it was an accidental finding at operation, or found in the sanctum of the pathologist.

Durrieux (9) in 1901 was able to collect but 194 cases in the literature, and many of these were autopsy reports. Hyman (15) states that in the American literature there were only about 6 cases reported up to 1906. Young (26) in 1906 found 5 cases in the world's literature in which the sac had been excised. In 1912 Lerche (19) noted records of 14 cases of excision and his own made 15. The introduction of cystography in this period led to the recognition of many more cases. It was, however, the idea of contrast cystography as advanced by Hinman in 1919 that gave the greatest impetus to the study of diverticula. Our own interest in this subject dates back about 25 years. At that time while in charge of the autopsy work of a large hospital we noted vesical pouches in 5 to 7 per cent of our material. In this series most of our subjects were bodies advanced in years. This being so we thought that age might be an etiological factor. This opinion we have subsequently modified.

In a previous contribution we have divided the history of ureteral stone into definite eras and this is a great aid in study. We shall therefore follow with diverticula of the bladder the suggestions of Durrieux who divides them into four eras: (1) the period of pathogenesis suggested by the writings of Morgagni and Houstet; (2) the stage of clinical study, covered by the work of Chopart, Civiali and Fallin; (3) the histological era and the formation of early theories regarding the presence or absence of bladder muscle; (4) the period of cystoscopy and surgical treatment, covering the epoch making contributions of Czerny and Nitze.

Much interesting study of this subject has been carried out by Blum (4) of Vienna, Durrieux of Paris, and still more recently in the excellent work of Mario Negri (22), one of the most progressive members of the modern French school of urology. The investigation of vesical diverticula and the solution of the problem is however fast becoming another diadem in the crown of those indefatigable spirits, the American urological surgeons. This is well shown in the splendid contributions of Herbst, Hinman, Hyman, Watson (25) and Rose (24).

ETIOLOGY

Just what is a bladder diverticulum? In our own introduction to the subject almost 30 years ago, we heard the late Dr. Forbes speak of those herniated spots in the bladder sometimes called diverticula. Is this the correct solution of the problem of etiology? Much of the early work in this line was carried out by the German School, more particularly Englisch, Pagenstecher, and Wagner. These writers claimed that there were two types of diverticula, the congenital and the acquired. It was thought that the congenital diverticula contained all the layers of the true bladder.

The acquired, it was said, was composed of a wall of fibrous tissue and epithelium. This reasoning has not withstood attack. While these two types undoubtedly do occur, they are now known as true and false respectively.

Before mentioning briefly our own views we shall note the opinions held by prominent investigators.

Anschuetz (2) believes that there is a congenital weakening of the bladder and that the diverticula are of the pulsion type. Cabot (6) believes them to be pouches of congenital origin. Day and Martin (8) are of the opinion that we have an embryological defect in the bladder, plus an obstruction at the vesical neck. Englisch (10) mentions true and false diverticula, the true covering all the coats, the false being limited to the mucous membrane. Our own studies are quite in accord with this finding and we believe false diverticula are by far more common.

Hinman (14) believes that there is a condition in the bladder conducive to diverticula and that the weakened spot responds to the increased tension caused by obstruction. Lennander (18) cites a bladder diverticulum in a child of 21 months, apparently caused by an obstruction of a marked phimosis. Lurz (20) believes that diverticula are of the pulsion type and only the predisposition is congenital. Rose (24) in his recent studies believes that all diverticula are congenital to the extent that an unprotected or direct loose fibrous tissue pathway must exist through the bladder wall before herniation takes place. Watson (25) in his excellent studies has shown that there is a definite developmental basis for those diverticula in the region of the trigone.

In our own studies of over 50 cases, we have been greatly impressed by the fact that in every instance in which a real diverticulum was found, there has been a urethral or vesical obstruction of more or less degree over a period of years. It is claimed by some that this merely draws our attention to the sacs. This is certainly by no means true for the reason that diverticulitis is a sufficient cause of real symptoms.

We have seen diverticula occurring in almost every part of the bladder in autopsy material and in the clinic. These specimens all presented a distinct defect in the bladder wall through which a herniation, incident to increased intravesical or extravesical tension, had taken place.

INCIDENCE

An examination of the records of a large number of hospitals shows a wide variation in the incidence of bladder diverticula.

In one series there is a record of 2 per cent of diverticula noted in the cystoscopic reports. Another clinic reports 5 per cent and a service of considerable size reports about ½ of 1 per cent. In our own observations the clinical and postmortem records seem to agree quite well; namely, a percentage of from 5 to 7. Inquiries at the large gynecological clinics in which considerable cystoscopy is said to be done show that diverticula are seldom seen. We cannot refrain from saying that we believe most of the statistics as related to the female are incorrect. Our reason for doubting these gynecological observations is that we have seen it many times in the female. In addition to this we have repeatedly seen them passed by in the women's clinics. About 2½ per cent occur in the female bladder.

Of all bladder diverticula, Judd and Scholl (17) report 133 cases treated surgically in 10 years. Hyman (16) in 1923 estimated that about 600 cases had been treated to that date. In examining many cystoscopic reports the following is noted: a bladder pouch in which a ureteral catheter has been coiled. These pouches are not called diverticula, but often are all one hears of what is really a large diverticulum. Indeed many diverticula are called cellules by the observer and labeled as such.

Hyman in his search of the literature found that of 600 reported cases about 30 were in children under 10 years of age. We have seen 1 case in a boy of 5 years who was also suffering from spina bifida. Hinman reports 1 case in a child under 10 years. In Fisher's series of 48 cases, 6 were in children, 2 of whom were cured by operation. One was a child of 20 months. In the cases compiled by Englisch in 1907, 171 in all, 22 were under 10 years, the youngest being 8 days. One case has been reported in a fetus. It is interesting to note

that some of the cases of very young patients were used to substantiate the congenital origin of diverticula.

In the records of 100 cases, 50 of which are our own, the following ages were noted:

Years	No. Cases
Under 10	5
10—20	3
20—30	6
30—40	11
40—50	30
50—60	41
60—70	2
70—90	2

The noteworthy fact about this table is that there seems a greater incidence between 40 and 50 than is generally recorded.

In regard to sex, the observation of Rose, of fixation at the trigone in male and female bladders, is a definite factor in explaining a relatively greater frequency of diverticula in the female.

LOCATION

The vast majority of bladder diverticula, in fact we may say 70 to 80 per cent, are located near the ureteral openings. We have, however, seen them in all parts of the bladder except the trigone. It has been said by some that diverticula located high up drain better and are more susceptible to treatment. This is very doubtful, as there does not seem to be any contractile power in these sacs which by the weight of their contents bar drainage. Infective and calculous formation seems to occur just as frequently when the sac is located in the dome as when it is on a lower plane.

Practically all diverticula are infected to a greater or less extent due to the presence of ammonia splitting bacteria.

Single	Cases
Right wall—ureteral	33
Right wall—lateral	21
Left wall—ureteral	11
Left wall—high	9
Base	1
Dome	5
	80

Multiple	Cases
Bilateral ureteral	3
Bilateral lateral	5
Double base	2
Right ureteral and left lateral	7
Five or more sacs	3
	20

SYMPTOMS

Symptomatology is a very brief chapter in the study of bladder diverticula. We do not mean that this condition is not productive of symptoms, but that it is lacking in characteristic features.

Sooner or later all types of the condition produce symptoms and it is often the associated diverticulitis and peridiverticulitis which is responsible for this. The double voiding, in which the patient apparently empties the bladder and the desire is apparent again in a few moments, is the nearest to a typical symptom.

Another but by no means common assertion is that the patient feels a ball which seems to rise and fall in the pelvis.

We hear hæmaturia at times spoken of in conjunction with this disease. When bleeding occurs we believe it is due to trauma, stone, tumor, or tuberculosis and is not caused by the sac proper.

DIAGNOSIS

The diagnosis of bladder diverticula as a rule can be made by means of a careful cystoscopic examination. There are, however, some cases which will escape the eye of the most painstaking observer. The cystoscope, while it gives us the location of the sac, does not distinguish retention and non-retention types. In the presence of masses it may also be unreliable; the same may be said of prostatic hypertrophy.

Cystography gives us the most exact diagnosis possible. In simple cystography, as usually practiced, a 12 per cent sodium iodide solution is used. This salt however seems to be quite irritating and many are unable to retain it. Of late we have been using a 5 per cent solution of neosilvol which is much less irritating to the vesical mucosa. There seems to be an impression that simple cystography gives us an exact idea of the position, size, and contour of the diverticular sac. This is not quite true. In many cases upon opening the bladder area we find a much greater sac than we had reason to anticipate. Simple cystography apparently was first practiced by Lerche of Minnesota in 1912. Lateral cystograms give a better impression of the divertic-

ula on any particular side. The contrast between an anteroposterior picture and a lateral is often quite striking. We regret to say that our own lateral pictures have not been very successful.

PROGNOSIS

The outlook for these cases, treated surgically, is good. We use this expression advisedly. The prognosis of the non-retention type is naturally better than that of the retention. When the sacs are not over 2 or 3 in number and are fairly regular in outline, the outlook is good. When the diverticula become numerous the possibilities of a cure are remote. However, when complete recovery is not obtainable, in practically all cases, alleviation can be expected. The presence of a marked peridiverticulitis lessens the patient's chances greatly.

Again we must allude to renal drainage, as with extensive kidney disease the prognosis is grave indeed.

TREATMENT

The means advocated for the relief of bladder diverticula may be palliative or radical. In this connection it is distinctly to be understood that these are both operative surgical procedures. Distinctly conservative nonoperative procedures accomplish nothing and must be disregarded.

One of the early operations, namely that of Pousson, in which the diverticulum is merely sutured is now an unsurgical procedure.

In many of these a preliminary treatment similar to that for prostatectomy must be carried out. The first radical operation for bladder diverticulum was practiced by Czerny (7) in 1896. The principal methods of radical treatment at present are the intravesical removal of Young and the combined intravesical and extravesical technique of Lower. It is our purpose in this paper to draw attention to all of the methods employed, particularly those less radical in form. In this connection we have been quite successful with the technique suggested by J. S. Read (23). We believe those measures will be much more extensively practiced when they are more widely known. Since many of these cases present a definite urinary obstruction, we must emphasize that this feature receives appropriate treatment before the diverticulum is considered. The preliminary case reports cover the forms of treatment usually indicated, from the extreme radical to the palliative form of procedure.

CASE 1. (Fig. 1.) J. L. D., age 52, white, married, was found to have large and small multiple diverticula of long duration, with peridiverticulitis and a median bar.

This patient was operated upon in a nearby city for a prostatic hypertrophy 3 years ago. At that time he was regarded as a poor surgical risk. A two-stage prostatectomy was done under local anæsthesia. In spite of all precautions the patient was in a state of severe shock after both stages. The suprapubic incision remained open for 2 years.

The patient is a rather frail looking man who complains of frequency half hourly during the day and hourly at night. The amount of urine voided varies considerably. Urine is distinctly ammoniacal and very foul. A residual of 10 ounces is noted.

Cysto-urethroscopy (Fig. 1) shows a very prominent median bar. In the vicinity of each ureteral orifice there are several openings of diverticula varying in size. Over the dome and posterior aspect of the bladder several orifices are seen, in all about 15. Through the cystoscope flaky pus could be seen emerging from several of the openings. In view of the general condition certainly no radical operation was permissible.

Treatment. The patient was placed at rest in bed for a couple of days, his bladder being irrigated night and morning with a 1 to 5,000 acriflavine solution. We had found this solution quite valuable in this class of cases. On the third day the patient was given a sacral injection of 30 cubic centimeters of 1 per cent novocain. Very liberal sections were then removed from the bladder neck by means of a Young punch. In spite of the utmost care considerable shock followed this minor procedure.

Following the operation the patient expressed very great relief. While there is slight cloudiness of the urine still present, he has no urgency or frequency. The patient voids every 3 hours during the day and once at night. He has also gained greatly in weight and strength. This case illustrates the improvement incident to removal of the urinary obstruction.

CASE 2. A. M. D., white, married, age 60, was found to have bladder diverticula with great hypertrophy of the interureteral bar.

The patient is a fairly well nourished man, but decidedly lacking in stamina. It appears that he was operated upon about a year ago for a supposed prostatic hypertrophy. From the reports we gather the gland was of the small fibrous type. He states that prior to his operation his chief trouble was frequency and urgency, a condition which still persists

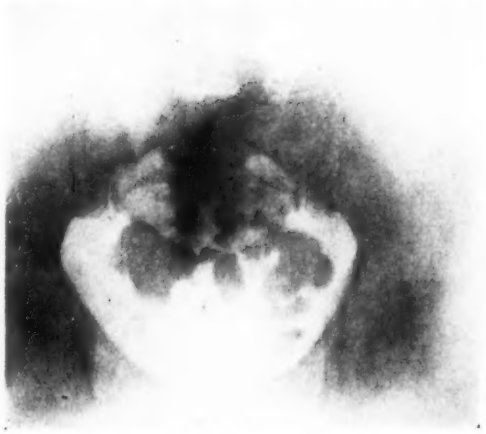


Fig. 1. Case 1.

Fig. 2. Case 2.

Although he seems reluctant about admitting it, there is quite a little dribbling. The urine is very cloudy and contains considerable pus. Examination shows about 4 ounces residual urine.

Cystoscopic examination shows a bladder somewhat trabeculated, with a quite large diverticular orifice just external to each ureteral orifice. The vesical orifice looks quite good. The interureteral bar however shows marked hypertrophy; the bar seems to divide the bladder into an anterior and a posterior pouch. The whole trigone including the so-called Bell's muscle is slightly involved in the hypertrophic process.

Cystogram (Fig. 2). One would expect in a case such as this to find an almost hour-glass appearance in the film. It, however, shows diverticula in the lateral wall as well as in the dome.

Treatment. This patient wanted relief without an operation. He was given a caudal anæsthesia and was cystoscoped. A very large fulgurating tip (the Collings instrument) was inserted and a good-sized section of the interureteral bar removed. After operation it was noted that while the sacs were still present, there was a marked improvement in the drainage. Another point is that later pictures showed less retention in the pouches. In other words they were distinctly less retentive in type. The urine seems almost clear, he voids every three hours and once at night. The relief in this case has been considerable.

Case 3. C. G. F., white, 51 years of age, married, native of Netherlands, had a bladder diverticulum and a stricture of the urethra.

This man reported complaining that there was at times difficulty in voiding. He also felt a sensation as if a ball were moving up and down in his pelvis.

Examination revealed a stricture of the urethra of about 17 F. Examination of the bladder showed a very well congested trigone and a group of cellules near the right ureteral orifice. These latter are apparently quite superficial. Near the left ureteral orifice there is an opening into which the ureteral catheter passes to its full extent. The vault of the bladder is apparently normal. Urine from both kidneys appears to be normal. We were unable to feel the ball in the abdomen which the patient complained of. However, while the sodium iodide was being injected for the purpose of making the cystogram, the patient stated he felt the ball increasing in size.

The cystogram (Fig. 3) was made with 12 per cent sodium iodide with air as the contrast. An examination of this plate shows quite clearly a very large retention diverticulum on the left side of the bladder.

Treatment. The patient was advised to have a series of ureteral dilatations until the calibre of the urethra admitted the passage of a 32 F. catheter and then to see that this calibre was maintained. The dilatations were readily accomplished. The diverticulum in this case did not seem to be causing any distress other than mental. The patient frankly came in and stated that the thing was getting on his nerve and that he wanted it removed.

Operation. Under local anæsthesia the bladder was opened and the sac freed from the surrounding tissues to which it was adherent, by a combined intravesical and extravesical manipulation. The sac was then packed with gauze as suggested by Lower and removed extravesically. Relief is apparently complete at present.

Case 4. J. A., Italian, married, age 52.

The patient states that he had always been well up to about 3 years ago, when he began to experience slight difficulty in voiding. There was also slight vesical tenesmus and at times the desire to urinate

Fig. 3. Case 3.

Fig. 4. Case 4.

became very acute. A little later he noted that there was less irritability, but was told by his doctor that the urine was loaded with pus. During the last year he has been bothered greatly with nocturia. He was operated on 6 months ago at a large western clinic and suprapubic prostatectomy was performed.

Three months after this operation he noted a fullness in the left side of the abdomen, with an increase in frequency and a terminal hæmaturia.

Examination by rectum shows large seminal vesicles which, however, can be emptied readily. The prostatic bed feels normal in size but is quite sensitive.

Cysto-urethroscopy. A McCarthy instrument enters readily. The fundus of the bladder appears normal. Upon the superior and lateral aspects of the vesical neck there are areas of bullous œdema. In the trigone there is a mass which suggests a series of papillomata. This area extends well down into the prostatic urethra. In the lower prostatic area pus can be seen exuding everywhere. This mass acts in an obstructive manner to the urethral canal. Specimens taken from all parts show inflammatory tissue only. Near the left ureteral orifice there is a cavity which fully admits a large catheter (Fig. 4).

Treatment. All attempts to reduce the mass in the trigone and prostate were futile. Another opening was made in the suprapubic area and the inflammatory mass at the bladder neck thoroughly destroyed by the actual cautery. The orifice of the diverticulum at the left ureteral opening seemed quite large. The diverticulum was then drawn into the bladder and resected intravesically as advised by Young. Convalescence was fairly good but the patient still complains at times of cloudy urine. Generally speaking the end-result is good.

Case 5. Mrs. G. S., age 65, widow, native of Poland, was admitted to the service October 5, 1924, complaining of difficulty in voiding and suprapubic pain.

The family history could not be successfully elicited. Aside from measles during childhood and several attacks of tonsillitis, the patient had always been well, having had no children or miscarriages. The patient denies having had any urinary diseases or infections, but admits that she had a leucorrhœal discharge for many years which she thought was only natural. The discharge apparently ceased about 6 months ago.

Present illness. For the past 2 years she has noticed a gradual diminution in the force of the urinary stream, with slowly increasing dysuria. Urination is a very slow and tedious process. The patient feels that she is fully able to empty her bladder. There are at times, however, sudden spurts of urine after bladder evacuation has apparently been completed. Micturition takes place about every 2 hours with apparently no urgency or frequency. In the last two months pain has appeared at a spot midway between the symphysis pubis and ensiform. This pain seems to bear no relation to the urinary act.

Urethral examination shows a stricture just within the urinary meatus which admits a 14 F. bulb on slight pressure. On attempting to withdraw same a distinct hang is noted near the external meatus The urine contains a trace of albumin, few red cells and many pus cells. The urethra was gradually dilated until it would admit a No. 18 McCarthy cystoscope.

Fig. 5. Case 5.

Fig. 6. Case 6.

Cystoscopy. The bladder mucosa on the vault and lateral aspects is anæmic. The bladder seems to dilate well laterally but is contracted in the antero-posterior dimension. The vault is decidedly higher on the right than on the left. The ureteral orifices are normal in appearance, apparently on the same level but a little farther apart than usual. Just to the outer side of the ureteral orifices there is an opening of a diverticulum.

The cystogram (Fig. 5) shows the diverticula clearly. The diverticulum on the right is of the retention type, the left only partially so. The urethral condition responded well to dilatation and the patient seemed relieved of all her symptoms. No change was noted in the sacs, and the patient desired no treatment for them.

This case seems to present in a rather striking manner a picture of congenital defect plus urinary obstruction as a cause of bladder diverticulum. We also feel that intrapelvic pressure has undoubtedly played its part as well.

Case 6. J. M., white, male, age 52, native of Russia, had a large right sided diverticulum with a small orifice, and a large left diverticulum with a large fibrous orifice.

The present complaint was incomplete evacuation of the bladder and burning pain in the perineum. The family and previous personal history has no bearing on the case. The patient admits several gonorrhœal infections at from 18 to 26 years.

Examination reveals a well marked median bar and a diverticular orifice near the last ureteral opening. That on the right is small while that on the left is quite large. Another small orifice is noted low down on the left side.

Cystography confirms the findings above noted (Fig. 6). In this case we resected the median bar with a Collings electrotome (nothing compares with it for this purpose). Three months later the diverticulum on the right was resected. The sac on the left proved much more extensive than it is shown in the illustration. As it was found to have a large fibrous ring we hoped to accomplish something by resecting it. With the aid of the electric scalpel the ring was eradicated. The patient has seemed to be quite well since his recovery from the operation.

Case 7. M. G., white, male, single, age 21, showed no diverticula.

This patient reported complaining of pain in the suprapubic area and cloudy urine, and stated that at times the pain ran up toward the right kidney. The pain apparently followed the course of the ureter.

The cystoscopic examination revealed pus in the bladder which evidently came from the prostate. The vault and lateral aspects of the bladder showed numerous cellules; in the region of the right ureter there appeared to be a narrow-mouthed sac. On attempting to pass a catheter something solid was struck and the catheter passed no farther. A catheter was passed into the right ureter and a picture taken. This suggested possible stone in the diverticulum. A cystogram was then made and this seemed to clinch the diagnosis—however, at operation the bladder was found quite normal and the mass was a large calcified area in the tip of the appendix.

SUMMARY

1. From our studies of bladder diverticula we feel sure that there are definite cases of congenital diverticula.

2. A congenital weak spot exists in the bladder in all cases.

3. Pulsion and pelvic adhesions provide the active means of producing the actual sac.

4. Medicinal treatment is of little value.

5. Some cases can be cured by excision.

6. In many cases cure cannot be effected but great relief may be secured by palliative procedures, such as those advocated by Read.

BIBLIOGRAPHY

1. Albucasis. Quoted by Nevitt, R. B., Hernia of the bladder. Dominion M. Month. 1906, xxvi, 121-125.
2. Anschuetz, W. Ueber kongenital Blasendivertikel. Ztschr. f. urol. Chir., 1922, x, 103–112.
3. Blasius, G. Observationes Medical Rariores Amstelodami, 1677, p. 59, Observation xviii.
4. Blum, V. Chirurgische Pathologie und Therapie der Harnblasen-Divertikel. Leipzig: Thieme, 1919.
5. Brussiere. Quoted by Blum.
6. Cabot, H. Bladder diverticula. Boston M. & S. J., 1915, clxxii, 300–302.
7. Czerny. Resektion eines Blasendivertikels. Beitr. z. klin. Chir., 1896, xxix, 247–252.
8. Day, R. V., and Martin, H. W. Diverticula of the urinary bladder. J. Am. M. Ass., 1925, lxxxiv, 268.
9. Durrieux, A, Les diverticules de la vessie. Thèse de doct., Paris, 1901.
10. Englisch, J. Ueber Taschen und Ausbuchtungen der Harnblasen. Wien. med. Wchnschr., 1894, xliv, 475.
11. Herbst, R. H., and Polkey, H. J. Tr. North Central Branch. Am. Urol. Ass., 1924, 9.
12. Idem. Causes of poor results after prostatectomy. J. Am. M. Ass., 1926, lxxxvi, 93.
13. Hinman, F. The etiology of vesical diverticulum. J. Urol., 1919, ii, 207–246.
14. Idem. Vesical diverticulum. Surg., Gynec. & Obst., 1919, 150–172.
15. Hyman, A. Diverticula of the bladder in children. Surg., Gynec. & Obst., 1923, xxxvi, 27–35.
16. Idem. Bladder diverticula in childhood. J. Urol., 1923, ix, 431.
17. Judd, E. S., and Scholl, A. J. Diverticulum of the urinary bladder. Surg., Gynec. & Obst., 1924, xxxviii, 14–26.
18. Lennander. Quoted by Lerche.
19. Lerche, W. The surgical treatment of diverticula of the urinary bladder. Ann. Surg., 1912, lv, 285–304.
20. Lurz, L. Kongenital Divertikel der Harnblasen. Ztschr. f. urol. Chir., 1925, xviii, 278.
21. Morgagni, Joannes Baptista. Epistoli Anatomico. Folio Venetia, 1761, ii, 42, 1682–1687.
22. Negri, M., Darriaux, and Blanc, H. Oblique cystography and lateral cystography. J. d'urol., 1925, xx, 193–200.
23. Read, J. S. A palliative treatment of bladder diverticula. J. Urol., 1925, xiii, 537–544.
24. Rose, D. K. Stages in the formation of bladder diverticula. South. M. J., 1926, xix, 206–212.
25. Watson, E. M. The developmental basis for certain vesical diverticula. J. Am. M. Ass., 1920, lxxv, 1473–1474.
26. Young, H. H. Operative treatment of vesical diverticula. Bull. Johns Hopkins Hosp., 1906, xiii, 401–446.

SACRO-ILIAC SUBLUXATION AS A CAUSE OF BACKACHE

By H. HOYT COX, M.D., F.A.C.S., Chicago

SACRO-ILIAC subluxation is a painful condition characterized by a definite displacement of the sacro-iliac joint with injury or faulty posture as etiological factors. The condition is usually unilateral but may involve both joints. These cases are quite common but rarely diagnosed, the complaint usually being mistaken for a contusion, lumbago, or sciatica. According to Goldthwaite (11) and Albee (1), a great majority of all backaches are due to the mechanical displacement of the sacrum and ilium.

The medical profession as a rule is woefully negligent upon the subject of backache, and the patient usually receives symptomatic treatment only, without the physician having a thorough understanding of the underlying pathology.

The subject is by no means new. It was described in 1854 by J. G. Fleming (8) of Glasgow, and again by E. L. Bertherand (3) in 1857. In 1878 Charles T. Poore (20) reviewed the literature on the diseases of the sacro-iliac joint. He referred to cases of relaxation due to the puerperal state and described in detail those cases due to injury.

Hirst (14) states that abnormal relaxation of pelvic joints is probably due to some pathological condition within the joint, usually an inflammatory process or new growth.

Jewett (15) mentions abnormal relaxation of the pelvic joints and gives the predisposing causes as osteomalacia, rickets, syphilis, tuberculosis, large fetal head, or faulty presentation.

Reynolds and Newell (21) state that there is occasionally a pathological mobility in the pelvic joints during pregnancy but gives no suggestions as to its cause or treatment.

Louis Cautin (4) deals exclusively with relaxation of pelvic joints during pregnancy.

Snelling (25) in 1870 described the condition as being specific to pregnancy and parturition and describes the sciatic pain which was present in his cases.

Fruitnight (10) in 1875 cited a case of relaxation of the sacro-iliac synchondrosis during gestation.

J. C. Edwards and A. F. Kerr (6), in 1889 reported in detail a clearcut case of sacro-iliac subluxation in a pregnant woman which came on suddenly when she arose quickly from a sitting position. A tight fitting support around the pelvis completely relieved the symptoms.

E. A. Lewis (16) in 1885, wrote a comprehensive article on the subject, reporting in detail two cases although he did not find definite evidence of separation.

The real credit for bringing this most interesting subject before the medical profession belongs to J. E. Goldthwaite (11) who in 1905 published the results of his extensive work based on 500 hospital cases, together with the results of an extensive anatomical research. He proved by the fresh dissection of bodies immediately at autopsy that motion exists and that the joint can be readily dislocated. The pelves were dissected leaving all ligaments intact. The sacrum was then sawed through from the lumbar articulation to the coccyx, and the sacro-iliac articulation was studied. The degree of motion was determined by driving nails into the ilium near the articulation and into the promontory of the sacrum parallel to the first; then by raising the leg 50 degrees with the knee straight, the ends of the nails separated about 3 millimeters. Dr. Goldthwaite described a plan of treatment, which consisted of replacement of the bones by hyperextending the spine by placing a firm pillow under the hollow of the back, or by allowing the patient to lie face downward with legs supported upon one table and head and shoulders upon the other. After reduction he recommended a plaster jacket and immobilization for 4 weeks. He also devised a test for sacro-iliac subluxation which consisted in having the patient stand on the foot of the affected side and flex the thigh with the leg extended, while the surgeon placed one

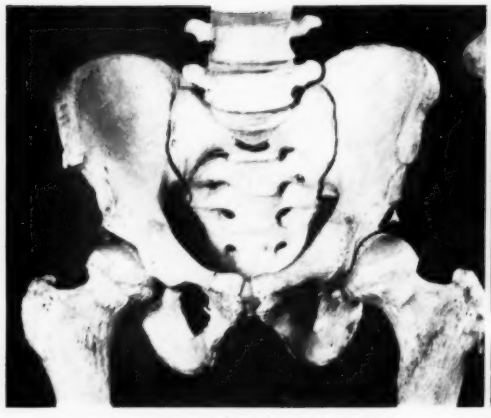


Fig. 1. Anterior view of sacro-iliac joint.

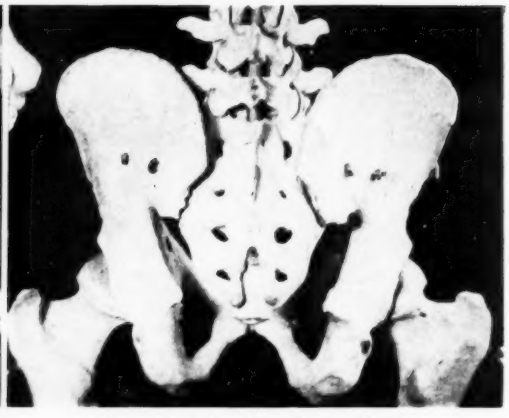


Fig. 2. Posterior view of sacro-iliac joint.

hand over the suspected joint and the other over the symphysis pubis. The latter will move with each motion of the leg, which motion according to Goldthwaite always occurs in sacro-iliac relaxation.

John Dunlop (5) gives the results obtained with 20 cases of subluxation of the sacro-iliac joint by treatment with pelvic supports without any manipulation. All patients recovered in from 3 to 6 months.

Ralph Fitch (7) divides the cases into two types: first, those due to definite injury; and second, those due to postural defects. He recommends tight pelvic supports and a pillow under the back and reports his results with 22 cases.

Albee (1) in 1909 noted the marked disagreement of the leading anatomists on the structure of the sacro-iliac joint, and dissected fifty cadavers. He concluded that the sacro-iliac articulation has all of the elements of a joint; that motion occurs in this joint especially in labor, and displacement is common. Its affections are undoubtedly the cause of many obscure backaches and persistent sciaticas.

Pittfield (19) gives a comprehensive description of the anatomy of the sacro-iliac joint, and describes a new test for sacro-iliac relaxation. He has the patient lie face downward on the bed, and then places his hand under the patient and firmly presses the pubic bones, at the same time moving the leg up and down. Prenatural mobility of the pubic joint caused by the relaxed sacro-iliac joint is easily detected.

Young (27) calls attention to the value of Kernig's sign in diagnosing luxations. He describes a manipulation which consists of placing the patient on abdomen and making traction on the affected limb. He emphasizes the value of the after-treatment and recommends exercise, massage, vibration, and electricity to all of the ligaments around the joint.

Hatch (12) advocates reduction by flexing the hyperextended leg with the patient lying on the back.

Roth (24) in 1913 recognized that lordosis and trauma were important etiological factors, and noted that subluxations predisposed tuberculosis.

Roberts (22) describes a case of marked traumatic dislocation of the sacro-iliac joint, with reduction by traction upon axillæ and affected limb with the patient lying face downward on a table.

Hayden (13) emphasized the important effect of faulty postures in the production of subluxations. He states that the subluxation may be backward or forward and seldom upward or downward, and that the backward displacement of the sacrum is most common. He recommends placing the patient on his back and flexing the thigh upon the abdomen with the knee extended to reduce the pos-

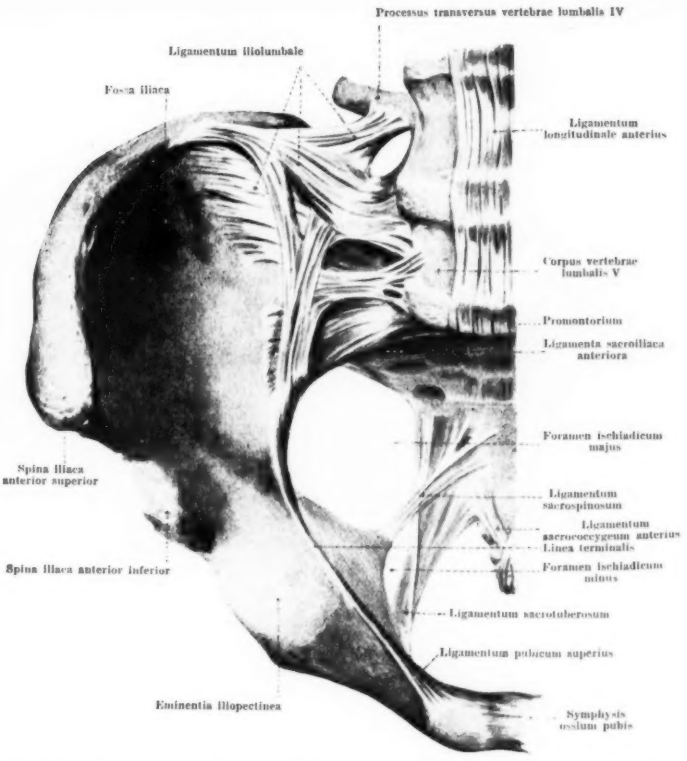


Fig. 3. Drawing showing ligaments of the right half of pelvis, from in front. (From Spalteholz.)

terior luxations and reversal of the motion and position for the anterior.

Paul Magnuson (17) in 1916 emphasized the etiological relation of defective posture and described an original manipulation for the reduction of the sacro-iliac subluxation. The patient was placed upon his back on a table and under anæsthesia, the straight leg was brought up to right angles with the body to increase the deformity and unlock the joint; then suddenly the leg was swung in hyperextension over the edge of the table. Following this manipulation a pillow was placed under the lumbar curve. Later the patient was fitted with a tight support and sacral pad to prevent slipping.

Frauenthal and Finkelstein (9) called attention to the frequency of subluxations and recommended a tightly fitting plaster jacket extending from the border of the ribs to the buttocks and in acute cases down the legs as a spica.

Wentworth (26) was able to demonstrate subluxations clearly with four cases, by means of the X-ray.

Allen (2) advocates the use of compressing traction and rotation of the crest of the ilium or pubes on each side of the body, while maintaining a firm grip on the sacrum through the rectum as an aid in reducing difficult subluxations.

Martin (18) emphasized the frequency of the occurrence of referred nerve pains in subluxations.

Roberts (22) in 1923 covered the subject in great detail, emphasizing the anatomy and mechanics involved and cautioned against diagnosing subluxation too frequently.

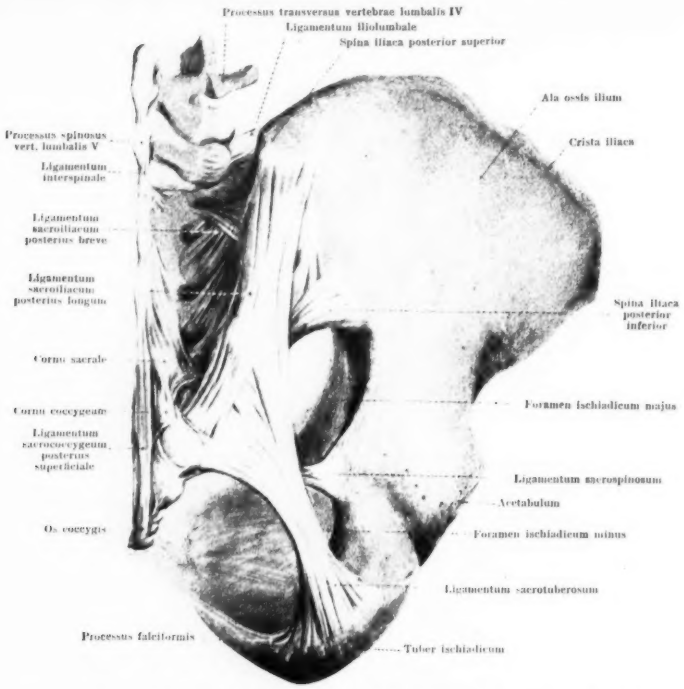


Fig. 4. Ligaments of the right half of the pelvis, from behind. (From Spalteholz.)

To correctly understand the pathology present in sacro-iliac subluxations, it is necessary to have a thorough knowledge of the anatomy involved. These articulations have the structure of a true joint and permit of a small amount of motion, the ilia moving upon the sacrum, or vice versa, the transverse axis of motion being at the level of the second sacral vertebra. The shape of the articulating surfaces of the sacrum and ilia is such that the surrounding ligaments and muscles are called upon to furnish the stability of the joint. The ligaments which hold the sacrum and ilium together are the anterior and posterior sacro-iliac and interosseous ligaments. The anterior are thin ligamentous bands which stretch from one bone to another. The posterior are much thicker and broader, being much stronger than the anterior ligaments. The interosseous ligaments lie on the dorsal surface and are made up of a mass of short fiber bands which are completely covered by the posterior sacro-iliac ligaments. They extend from the sacral tuberosity to the iliac tuberosity and fill the depression behind the joint cavity between these two rough surfaces. These ligaments proper are supplemented by the greater and lesser sacro-iliac and lumbosacral and ilio-lumbar ligaments from the transverse process of the last lumbar vertebra. Thus normally the articulation is a very strong one of necessity being made stronger posteriorly.

There are two distinct types of sacro-iliac subluxation. First, those due to a definite injury, such as a fall, heavy lifting, or the sudden arising from a stooping position or a sitting posture, or a sudden lateral twisting of the body. Second, those due to faulty posture over a long period of time, whereby the sacrum becomes tilted abnormally and the lumbar curvature becomes obliterated. The familiar flat back frequently seen in patients who have had prolonged recumbency, or faulty occupa-

tional postures clearly illustrate this second type of case. The lumbar curve of the spine becomes obliterated and the ilium is consequently tilted forward at an abnormal angle with the sacrum giving the appearance of a flat back.

Characteristic of the first type is the sudden onset, the so-called stitch in the back. The patient will give a history of having missed a step while coming up the stairs, of suddenly arising from a stooping position while picking something up, or sudden heavy lifting or a sudden twist of the pelvis due to a fall. He is immediately seized with an excruciating pain in the affected sacro-iliac joint and is unable to straighten his body. The lumbar curvature is frequently obliterated. It is quite evident that some mechanical derangement has occurred. Occasionally, the condition may occur suddenly during sleep being caused by lying on the back and thus flattening the lumbar spine. This position necessarily strains the sacro-iliac ligaments and muscles which soon become relaxed and a definite slipping of the bones occurs with the production of severe pain. The patient is awakened by backache of a very acute character, which is usually relieved by stretching or hyperextending the spine.

In the second type of case the symptoms are of slow onset and referred pains do not develop for some little time. Faulty attitudes and postures are the etiological factors here, usually due to the patient's occupation, although general lack of muscular tone is usually present. The sacro-iliac ligaments are put upon a strain and dull aching pain, which may be quite severe, is produced. This pain is at first due to muscle fatigue from the attempt of nature to support the weakened joint. Later, however, the pain is caused by the displacement of the sacrum and ilium. These postural defects tend to obliterate the lumbar curve and put great strain upon the ligaments and muscles. Examples of this type are seen in patients who are accustomed to sit with their lumbar curves thrown back while driving an automobile, in firemen and in laundresses who have to bend over. The above postures produce a relaxation of the ligaments with a consequent subluxation of the joint.

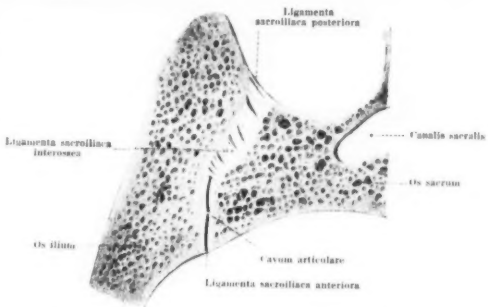


Fig. 5. Frontal section of right sacro-iliac joint. (From Spalteholz.)

Although I have classified sacro-iliac subluxations as belonging to two great classes: acute, which are traumatic, and chronic, which are postural, there are other contributory factors which, while not so important, must be considered.

Normally, motion exists in the sacro-iliac joint during pregnancy, but during parturition and menstruation, the amount of motion is increased due to a normal relaxation of the pelvic joints which may become severe enough to produce a subluxation. Trauma and faulty posture at this time undoubtedly play an important etiological part. During the latter months of pregnancy there is a hyperextension of the spine due to lordosis. This position together with the physiological relaxation make conditions ideal for the production of a subluxation.

Diseases such as infectious arthritis, hypertrophic arthritis, and rheumatoid arthritis predispose to relaxation of the sacro-iliac joint.

The articular surfaces of the joint are formed so as to make motion possible only in certain directions. The motion upon the transverse axis has its center at the lower portion of the sacro-iliac articulation, through the second sacral vertebra. Because of the arrangements of the ligaments and the shape of the surfaces of the bones forming the joint, the motion must be a forward motion of the ilium at the top and backward at the lower end of the articulation, or vice versa, unless the slipping be extreme.

The most commonly seen malposition has been described by most authors as a true back-

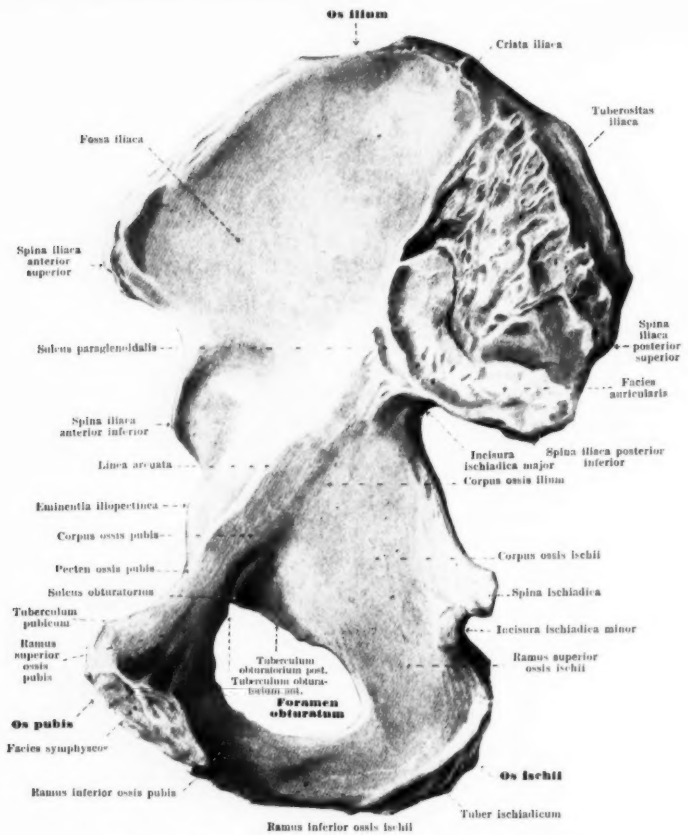


Fig. 6. Right hip bone, from within. (From Spalteholz.)

ward subluxation of the upper part of the sacrum away from the ilium. An investigation which will be described later seems to indicate that the real pathology is a forward slip of the ilium at the upper part of the joint away from the sacrum which remains stationary, and it is usually unilateral. The lumbar curve is usually obliterated. Let us consider for a moment the mechanism of an acute subluxation caused by a sudden misstep while climbing stairs. The spine is somewhat flexed, but when the misstep occurs, sudden violent hyperextension of the spine takes place in an effort to recover the balance, while at the same time there is a sudden powerful forward pull on the anterior part of the ilium due to the action of the quadriceps, sartoriun, pectineus and iliacus muscles, which are attached to the tibia below the knee. These two forces acting in opposite directions at the same time, cause a forward displacement of the ilium away from the sacrum at the upper part of the joint. This mechanism holds true for those subluxations which suddenly occur while bowling, lifting heavy weights, or arising suddenly from a stooping position or a sitting posture. In fact the same mechanism has been present in practically all of the cases.

SYMPTOMATOLOGY

The history in the great majority of cases is similar. Backache, usually unilateral, is the predominating symptom and dates back to a definite injury or to a prolonged defective

posture which is usually occupational. Occasionally the patient cannot recall any history of trauma or give a possible etiological factor.

The onset differs in the acute cases from that of the chronic postural. For example, the onset is sudden, following arising from a stooping position, lifting, misstep, twisting of body, usually laterally with the thigh abducted, or a blow over the sacro-iliac joint. Excruciating pain comes on immediately, and the patient has difficulty in straightening up or in walking. Pain is associated with all motions or postures requiring movements of the sacral region, such as sitting, getting up and down, stooping or even lying.

In the chronic cases, the onset is more gradual and may date from an injury or from prolonged faulty posture which is usually occupational. The backache is more apt to be generalized and involve both joints, than in the acute type, and is not of such a severe nature. He may frequently give a history of having used a pillow under the small of the back for the relief of pain. The pain is due both to the subluxation of the joint and to muscular fatigue from the attempt of nature to support the weakened joint.

Referred pain down the leg on the affected side is more common in the chronic cases than in the acute, but develops at a later date. It is frequently present in the acute cases, however, and may come on at once. This referred pain is due to a true sciatica produced by the mechanical irritation of the lumbosacral cord where it passes over the brim of the pelvis, its point of passage being directly over the upper part of the sacro-iliac joint where it is bound closely to the anterior ligaments of the joint and passes directly anteriorly down and outward to the lower pelvis and leg. The gluteal nerves also cross this joint anteriorly. In any displacement the edge of the bone is so exposed that pressure or stretching of the plexus can hardly be avoided. The severity of these referred pains may be great and may be referred to the thigh, hip, calf, or down the back of the leg, following the distribution of the sciatic nerve. The character of this pain is usually steady, being made worse by walking.

Fig. 7. Illustrating mechanism.

Upon physical examination sometimes nothing can be seen on inspection of the sacral region, but usually there may be found:

A marked prominence of the sacrum;

Rigidity of the spinal muscles due to spasm;

Obliteration of the lumbar curvature, due to anterior displacement of the ilium;

Lateral curvature of the spine away from the side affected;

There may be some swelling of the joint due to distention of fluid although this feature was not observed in our series;

Marked tenderness to pressure over the affected joint.

The patient usually assumes a stooping posture with the knees slightly flexed. Any motion which flexes the thigh while the knee is extended causes severe pain in the sacro-iliac joint and down the thigh and leg. This is because flexion of the thigh with the knee extended tightens the hamstring muscles, and as the the latter are attached to the tuber ischii, such motion will tilt the ilium forward upon the sacrum and by increasing the deformity produce an exacerbation of pain.

Abduction or outward rotation of the thigh does not cause pain, but extensive adduction

Fig. 8.

Fig. 9.

Fig. 8. Photograph of patient before reduction. Note straight back.
Fig. 9. Same patient as in Figure 8, after reduction.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 10. Photograph showing deviation of spine.
Fig. 11. Same patient as in Figure 10, before reduction.
Fig. 12. Same patient as in Figure 10, after reduction.

or inward rotation of the thigh does produce pain as it tends to separate the sacro-iliac articulation.

Compression of the crests of the ilia produces severe pain by causing separation of the sacrum and ilium.

The most important diagnostic sign is marked tenderness to pressure over the affected joint. Stooping is done with difficulty and pain, and may be impossible unless the knees are flexed and the spasm of the hamstrings thus released.

Forward bending, if attempted while standing with the knees straight, is limited, but is more free if the knees are flexed as when sitting. In the first position the hamstring muscles are made tense and pull upon the tuber ischii, increasing the deformity and producing muscular spasms. However, when the knees are flexed, the muscles are relaxed and the spinal movements can be made more freely. Adduction with the thigh flexed produces pain. Also, elevation of the leg with the knee extended is limited, due to spasm of the hamstrings.

In making a differential diagnosis consideration should be given contusions of the sacro-iliac joint, hypertrophic arthritis, chronic sciatica, neurasthenia, tuberculosis of the sacro-iliac joint, lumbago or so-called muscular rheumatism, and typhoid spine.

We find that in contusions the symptoms are more severe and persist longer than they do in a subluxation.

When the pelvis is firmly held all motions are much more free and less painful, as the muscular pull upon the sacrum and ilium is relieved. This feature is important in differentiating a hypertrophic arthritis, as in the latter, the limitation of motion would be constant and would not be influenced by changes of position or support. In hypertrophic arthritis, the decreased function together with the constant nerve irritation produces muscular atrophy, which is not usually present in sacro-iliac subluxations.

Fig. 13. Roentgenogram showing separation of joint.

Fig. 14. Specimen showing relation of sacral plexus to sacro-iliac joint.

Chronic sciatica is, of course, only a symptom and is usually due to pressure or irritation of the sciatic nerve from some external source. However, it may be due to focal infection in rare instances, but according to Goldthwaite most cases of chronic sciatica are due to sacro-iliac subluxations.

Neurasthenia in relation to backache in the great majority of cases should not be considered, as it is usually an excuse for our inability to make a diagnosis. I have fresh in my mind a case of tuberculosis of the sacro-iliac joint with associated sciatica which was diagnosed as neurasthenia until a large abscess formed.

Tuberculosis of the sacro-iliac joint, while rare, is much more common than is generally supposed. It is very apt to be mistaken for a relaxation of the sacro-iliac joint as the symptoms are similar. However, in tuberculosis the onset is insidious, the pain is of a dull aching character, worse at night, and more severe upon walking. Abscess formation usually occurs early and the changes can usually be seen early by the roentgenogram. General debilitating symptoms, with atrophy of the affected leg, occur early. Aspiration of the abscess, if present, will often show the organisms, or guinea pig inoculation will reveal the cause.

Most cases of lumbago, according to Magnuson, are subluxations of the sacro-iliac joint. There are, however, certain cases of a true myalgia affecting the lumbar muscles which are of an infective nature. The pain is higher and extends across the back, with marked tenderness of the lumbar muscles, but not over the sacro-iliac joints. The patient complains of a stiff painful back which is relieved by sitting or lying down. Upon arising he has difficulty in straightening the body.

Typhoid spines are sometimes due to subluxations, long rest in bed with subsequent relaxation of the ligaments and muscles, predisposing to the condition. However, the history of typhoid and the roentgenogram should make the diagnosis clear.

As strange as it may seem, the X-ray offers little help in the diagnosis, positive findings being secured in only 7 out of 300 of Paul Magnuson's series, and in only three cases of my series.

TREATMENT

The principle of the correct treatment is to restore the normal relations between the sacrum and ilium and to maintain them by suitable support. The reduction of the subluxation should be accomplished at once. Remembering the pathological process, which consists of a definite displacement forward

Fig. 15. Photograph illustrating manipulation of patient.

of the ilium from the sacrum at the upper part of the joint produced by extreme hyperextension of the spine together with the strong muscular pull on the anterior part of the ilium, it is readily seen that these two forces acting in opposite directions at the same time produce the forward displacement of the ilium at the upper part of the joint. The position is maintained largely by the spasm and the pull of the hamstrings on the tuber ischium, which tends to rotate the ilium forward. The treatment should be based on principles which take into consideration the pathology that exists. Gunn's rule, which is "to place the extremity in the position it occupied at the time of the dislocation and reverse the force," is applicable here the same as in any other case of dislocated joint, and I will describe in detail a maneuver based on this rule which I believe to be original, as a thorough search of the literature does not reveal any similar manipulation.

The patient is placed on the table, face downward, his weight being supported by the elbows and abdomen, and his hands grasping the edge of the table securely. The surgeon while standing on a box near the feet of the patient, firmly grasps his ankles and lifts his body clear of the table, the body being supported above by the elbows alone. It is held in this manner for several minutes, with the legs in abduction, strong steady traction being made on the affected leg, while an assistant makes firm pressure over the sacrum. The body should be lifted up and down while the traction is being made. There is usually sudden marked relief as the bones slip into place, and the lumbar curvature is in most instances restored at once. The mechanism is as follows: In lifting the patient's body by the ankles, we are hyperextending the spine and thus relaxing the strong posterior sacroiliac ligaments and also relieving the joint from the pull of the hamstrings. The abduction relieves the supporting action of the psoas muscles. In other words, we are placing the joint in the position it occupied at the time of displacement which is hyperextension. The strong pull upon the leg of the affected side unlocks the joint by increasing the deformity due to the action of the extensor quadriceps muscles, especially the rectus femoris, sartorius and iliacus which exert a downward and outward pull upon the upper anterior part of the ilium, thus increasing its separation from the sacrum and at the same time relaxing the pull from the hamstrings. Reversing the force occurs when the weight of the body drags the spine forward and favors replacement of the ilium by forcing the sacrum forward. This process is aided by pressure being made over the sacrum by an assistant and by the steady traction upon the affected limb, which, as was noted, also tends to unlock or separate the joint. It can be readily seen that the dragging position of the suspended body, together with traction on the affected side, which relaxes the joint, and firm pressure over the sacrum will tend to replace the bones, thus fulfilling Gunn's rule. After replacement, a firm support of adhesive tape is passed behind from in front of one great trochanter to the other. It must be remembered that it is essential to place the support low, well down on the buttocks, below the level of the trochanters, as any lateral pressure above this point tends to separate the joint and produce great pain. The straps should extend from the anterior part of the ilium on one side to a similar point upon the other side, and should cover the buttock and lower lumbar spine, below the trochanters. I always put a firm pad of cotton or felt over the sacrum so that pressure is maintained on it at all times. This dressing should be reapplied in about 6 days. The patient should be put to bed for one week if the displacement is acute, and a small firm pillow so placed as to maintain the lumbar curvature and keep any strain off the injured ligaments.

There is no single manipulation in surgery that gives more immediately spectacular results. A patient is seen suffering excruciating pain, the lumbar curve is obliterated, and he is scarcely able to stand. After the manipulation in the great majority of cases, he obtains immediate relief and feels practically as good as before. Untreated, these patients suffer indefinitely and inflammation frequently develops in the affected joint. These are the patients with chronic sciatica, lumbago, and muscular rheumatism that make the rounds of the physicians unsuccessfully and finally end up with osteopaths or chiropractors. In all cases I recommend that a supporting belt with a firm sacral pad lacing at the front, be worn low down on the pelvis, the upper part of the belt always being below the iliac crests. The trouble with the ordinary sacro-iliac belt is that it is made to be worn too high instead of low down on the pelvis at the level of the great trochanters. If the belt is too high pressure is exerted against the crests of the ilium and the separation of the bones increased, and the purpose of the belt is defeated, whereas if the belt is low the sacro-iliac joint is compressed and supported. These supports are to be worn for 6 months and can be removed at night provided a small pillow be kept beneath the lumbar spine.

In the great majority of the acute cases this is all the treatment that is necessary. The patient should be cautioned against slipping, stooping with the knees stiff, sudden twisting, or running as recurrences are frequent within the first 6 months. If there is no recurrence within that time, it is safe to assume that the joint has been restored to its normal condition.

Occasionally, and especially if the condition had existed more than one week, manipulation and support occasionally fail to effect an immediate cure, the reason being that an inflammatory process has already been set up in the ligaments or joint. Recovery will not take place until this inflammation subsides, and I know of nothing better to hasten the disappearance of the inflammation than diathermy given daily for about 24 treatments. This together with rest in bed and proper support will cure practically all of the acute cases. The sciatica which occasionally complicates the subluxations usually subsides rapidly after replacement of the bones, support, and rest in bed. However, diathermy along the course of the nerve has a most beneficial effect.

The treatment of the chronic cases due to faulty posture must have a somewhat different management. As a true relaxation exists, the bones should be replaced by the manipulation and the patient securely strapped with adhesive. In addition to the subluxation we have also an inflammation of the joint either one or both, to deal with. The patient should be kept in bed for from 2 to 4 weeks with a small firm pillow beneath his lumbar spine. If the pain persists or a true sciatica is present, Buck's extension on the affected side will hasten recovery by relaxing the muscles and ligaments and immobilizing the extremity. I have occasionally injected the sciatic nerve with ice cold normal salt solution with prompt disappearance of the pain in the leg. This procedure, however, is rarely necessary. A plaster-of-Paris spica cast put on immediately after the reduction and kept on for from 2 to 4 weeks is a very satisfactory treatment, as the immobilization allows the inflamed ligaments to heal. All pain usually disappears within several days after either the Buck's extension or the cast.

Where inflammation or infection of the joint is present following a chronic subluxation, there is reason to believe that focal infection plays an important rôle in prolonging the disability. All abscessed teeth and infected tonsils should be removed. I have two cases in mind in which recovery took place only after the removal of some gangrenous hæmorrhoids. The entire general system should be toned up so as to afford all possible aid to the weakened ligaments and joints.

There are some cases of repeated recurrent subluxations which will fail to respond to the above treatment and immobilization of the joint by open operation with ivory pegs as recommended by Magnuson, or the bone inlay as done by Albee offers the best chance of a permanent cure.

Table I gives the results in my series of 80 cases.

TABLE I.—RESULTS

	Cases
Total number treated	80
Acute cases—treated by manipulation, strapping, rest in bed for 1 week	65
Relieved	65
Complete permanent relief	50
Complete relief but recurrence in 6 months	13
Recurrence—once only	4
Recurrence—twice or more	10
No relief obtained	0
Improved but not cured	2
Chronic cases	15
Complete permanent relief following manipulation alone	5
Benefited but symptoms not immediately relieved	8
Complete permanent relief following manipulation and Buck's extension, immobilization and diathermy	4
Relieved by manipulation and immobilization; complete recovery following hæmorrhoidectomy	2
Relieved by treatment; complete recovery following tonsillectomy	2
Unimproved	2
Cases treated by manipulation alone	10
Relieved at once	10
Recurrence	1
Cases treated by manipulation and strapping without rest in bed	20
Relieved at once	20
Recurrences	2

RESULTS OF ANATOMICAL RESEARCH PERFORMED ON THIRTY SPECIMENS

Realizing that a great deal of uncertainty exists in regard to the structure and function of the sacro-iliac joint we made a careful dissection of thirty specimens with the view of ascertaining the true anatomy and physiology of the joints. This work was carried on at the Anatomical Laboratories of Northwestern University.

The observations made were as follows: the sacro-iliac joint is a true joint possessing synovial membrane which is much thicker on the sacral side, synovial fluid, and a weak capsule. Motion was elicited in every specimen and varied from 1 millimeter to 3 millimeters. In our cadavers, in variance with the statements of other writers, we found that the sacrum was fixed and did not move at all. The motion consisted of rotation both forward and backward of the ilium on the sacrum, mainly at the upper part of the joint. We were able to produce definite slippings of the joint which consisted most frequently of an anterior displacement of the ilium on the sacrum. Definite locking occurred by forcing the ilium forward and downward which condition was relieved by further separation of the joint. We were not able to produce any permanent displacement posteriorly of the ilium on the sacrum although the ilium was displaced posteriorly in every case from 0.5 to 3 millimeters when the thighs were flexed on the abdomen. We observed that the powerful psoas muscle acted as a brace to maintain the strength of the sacro-iliac joint and that it was only after abducting the thigh slightly and thus relaxing the psoas muscle that we were able to produce appreciable motion anteriorly in the sacro-iliac joint. Motion was demonstrated by driving a nail into the promontory of the sacrum, another in the sacrum close to the joint and another in the ilium close to the joint, all being in a straight line. By flexing the thigh on the abdomen the nail driven into the ilium separated from the line of the other nails from 0.5 to 3 millimeters, and upon hyperextending the spine and the thigh, thus causing the extensor muscles to pull on the ilium, the nail in the ilium separated from the straight line from 0.5 to 3 millimeters in the different specimens. The degree of motion was increased by abducting the thigh and thus relieving the support of the psoas muscle. This procedure definitely showed motion to exist in the joints normally both anteriorly and posteriorly.

Upon dissection of a locked joint, it was found that the locking was due to one or more of the roughened projections becoming impinged in a corresponding cavity of the opposite bone. The displacement appeared to be at the upper part of the joint and because of the ilium being pulled forward the appearance of a flat back resulted.

BIBLIOGRAPHY

1. Albee, F. H. A study of the anatomy and clinical importance of the sacro-iliac joint. J. Am. M. Ass., 1909, liii, 1273–1276.
2. Allen, H. R. The sacro-iliac joint. J. Am. M. Ass., 1921. lxx, 854.
3. Bertherand, E. L. Recherches sur la luxation sacro-iliaque. Ann. m'd. de la Fland., acc., Roulers, 1857, ix, 3, 33.
4. Cautin, Louis. Relachement des symphyses et aretralgies pelviennes, d'origine gravidique. Thèse de doct., University of Paris, 1899.
5. Dunlop, J. New York M. J., 1926, p. 84.
6. Edwards, J. C., and Kerr, A. F. Luxation of sacro-iliac articulation. Lancet, Lond., 1889, i, 1056.
7. Fitch, R. R. Mechanical lesion of sacro-iliac joints. Am. J. Orthop. Surg., 1908–09, vi, 693–98; 731.

8. FLEMING, J. G. Separation of the sacro-iliac symphysis. Glasgow M. J., 1854, ii, 455–463.
9. FRAUENTHAL and FINKELSTEIN. Sacro-iliac dislocation. Internat. Clin., 1918, iv, 60.
10. FRUITNIGHT, J. H. Case of relaxation of the sacro-iliac synchondrosis during gestation. Am. J. Obst., 1875–76, ix, 635–637.
11. GOLDTHWAITE, J. E., and OSGOOD, R. B. Consideration of pelvic articulations from anatomical, pathological and clinical standpoint. Boston M. & S. J., 1905, May 25 and June 21.
12. HATCH, E. S. Strains and dislocation of the sacro-iliac joints. Southern M. J., 1912, v, 153–157.
13. HAYDEN, J. G. Sacro-iliac strains and luxations. J. Mississippi M. Ass., 1916, xiii, 531–534.
14. HIRST. Textbook on Obstetrics.
15. JEWETT. Practice of Obstetrics.
16. LEWIS, E. A. The diagnosis of injuries to the sacro-iliac articulation. New York M. J., 1885, xl, 715–717.
17. MAGNUSON, PAUL. Backache, acute and chronic from a mechanical standpoint. Read at joint meeting of surgeons of the Illinois Central and Yazoo and Mississippi Valley Railroad Companies, Chicago, May 26 and 27, 1916.
18. MARTIN, E. D. Sacro-iliac sprain. Tr. Southern M. J., 1922, xv, 135–139.
19. PITTFIELD, R. L. Relaxation of the sacro-iliac joints as a cause of sciatica and backache. Am. J. M. Sc., 1911, cxl, 855–863
20. POORE, C. T. Diseases of the sacro-iliac joint. Am. J. M. Sc., 1878, January 1.
21. REYNOLDS and NEWELL. Practical Obstetrics.
22. ROBERTS, C. S. L. Some consideration of the sacro-iliac joint. Lancet, Lond., 1923, p. 926.
23. ROBERTS, J. B. Sacro-iliac subluxation. Tr. Philadelphia Acad. Surg., 1914, xvi, 32–37.
24. ROTH, P. B. Relaxation of sacro-iliac joint. Proc. Roy. Soc. Med., Lond., 1913–14, vii, Surg. Sect., 54–58.
25. SNELLING, FREDERICK J. Relaxations of the pelvic symphyses during pregnancy and parturition. Am. J. Obst., 1870, ii, No. 4.
26. WENTWORTH, A. L. Demonstrable luxation of sacro-iliac joints. Am. J. Orthop. Surg., 1918, xvi, 443–445.
27. YOUNG, J. K. Sacro-iliac displacements. Interstate M. J., St. Louis, 1915, xxl, 849–856; and sacro-iliac displacement. Am. J. M. Sc., 1912, cxliv, 94–103.

SPINAL ANÆSTHESIA

A REPORT OF THREE HUNDRED AND NINETY-TWO CASES

BY COMMANDER JOSEPH J. A. McMULLIN, M.D., M.C., U.S.N., LEAGUE ISLAND, PENNSYLVANIA

IN reporting this series of 392 spinal anæsthesias, performed at the United States Naval Hospital, League Island, Pennsylvania, we do not wish to put forth the opinion that this form of anæsthesia is ideal. The question of its safety is debatable. It does not invariably produce analgesia; it does not always last long enough to complete prolonged operations; it is not without exception regarded by patients as pleasant to take; it is usually accompanied by a fall of blood pressure, often by nausea and vomiting, and sometimes by alarming vasomotor and respiratory collapse. Many surgeons regard spinal anæsthesia as unsafe and unreliable.

Having enumerated some of the conspicuous bad features of spinal anæsthesia, we are prepared to make some frank comments, based on our limited personal experience.

An anæsthetic should be safe, never fail to produce anæsthesia, should be pleasant to take, give satisfactory relaxations, and be free of untoward after effects.

There is no anæsthetic known which fulfills all these ideals. Ether is generally regarded as a safe and satisfactory anæsthetic. Ether has stood the acid-test of time; it is almost fool-proof. Nitrous oxide and ethylene are excellent anæsthetics, but they do not produce satisfactory relaxation unless combined with local anæsthesia. There is a tendency at the present time toward local anæsthesia. There is a reason. In fact there are several reasons. A local anæsthetic is safe, produces excellent relaxation, is not very unpleasant to take if expertly administered, and is at least quite as free from untoward after effects as are general anæsthetics. It was thought that local anæsthesia would eliminate pulmonary complications, but this hope has not been realized. We see post-operative pneumonia and pulmonary embolism following local anæsthesia. Patients suffering from acute and chronic respiratory

infections frequently come to us requiring immediate operation. Such cases undoubtedly run less risk of postoperative pneumonia and pulmonary abscess if a local or spinal anæsthetic is used. No matter what the anæsthetic may be the patient will probably perspire freely during the operation, and it is my firm conviction that at least some postoperative pneumonias are produced by chilling of the patient, either on his trip back to bed or after he arrives there.

If the patient's pajamas need to be changed, care should be taken to prevent chilling during the act. The ventilation of wards and private rooms will also bear watching. A headache from insufficient ventilation is preferable to a chestache from too much ventilation. The old fashioned draught is just as potent as it was in the days of yore.

Pulmonary embolism happens more frequently than statistics indicate. Many so-called postoperative pneumonias are really instances of embolism with infarction. Fatal or near-fatal cases are the ones generally recognized. When we recall that a clot in the venous circulation is carried to the right heart and then directly to the lungs, it is reasonable to suppose that small clots frequently lodge in the smaller branches of the pulmonary artery, and produce symptoms which pass muster as bronchitis and pneumonia. There is no convincing proof that spinal and local anæsthesia has lessened the frequency of pulmonary embolism and thrombosis.

In this series of spinal anæsthesias we had two alarmingly severe reactions, but no deaths. In both instances the injections were made in the eleventh thoracic interspace. In one case the patient appeared to be dead. He was pulseless and breathless. When intravenous saline was administered it was necessary to expose his vein by dissection. The vein was cut to permit the introduction of a cannula. During the dissection for the vein, and after the vein was cut, there was not a drop of blood in evidence. After the patient had been given about 300 cubic centimeters of salt solution (containing 0.1 per cent adrenalin) his pulse became perceptible and his respirations—at first slow and irregular—returned. When the transfusion (1,000 cubic centimeters) was completed, his pulse, respiration, and blood pressure had returned approximately to normal. Less than 3 minutes elapsed from the time this patient went into collapse until the intravenous salt solution was started. This patient also received 1/75 grain of atropine hypodermically. Atropine is a vasomotor stimulant, and if absorbed might be expected to be of value in vasomotor collapse.

Mild reactions were too numerous to enumerate. The average drop in blood pressure for the series was 18 points systolic and 15 points diastolic. The pulse rate was frequently, but not as a rule, markedly decreased. Many patients showed pallor, nausea, and vomiting. We treat these mild reactions by placing gauze wrung out in ice water over the forehead, and by inhalations of ammonia. We have had no severe reactions when the injection was made in, or below, the second lumbar interspace.

In 10 cases, adequate and satisfactory anæsthesia was not obtained; in 14 cases, perfect anæsthesia was obtained for approximately 1 hour, but it was necessary to supplement spinal with local or general anæsthesia to complete prolonged operations.

Failure to obtain anæsthesia is probably due in large part to faulty technique, the full amount of the local anæsthetic not being introduced into the subarachnoid space. In intravenous injections the needle may obtain blood, but fluid injected may go into the cellular tissue outside the vein; so, also, in intrathecal rachi-anæsthesia the needle may obtain liquor spinalis, but the anæsthetic when injected may not all find its way through the meninges, but may be discharged into the cellular tissue surrounding the theca; or some of the solution may leak through the opening. Therefore, with a small bore needle properly introduced, and with sufficient dosage of a potent local anæsthetic, anæsthesia should invariably be produced.

Another cause for failure is over-sterilization of the anæsthetic.

Given properly and in sufficient dosage the local anæsthetic should be responsible for few failures. As our experience increases our

failures decrease. We formerly gave 1 grain of novocain for each 100 pounds of body weight. We now give 2 grains to adults irrespective of age, weight, or blood pressure.

One of the most commendable features of spinal anæsthesia is the relaxation obtained. In abdominal surgery relaxation and success go hand in hand. Relaxation makes for better exposure. When relaxed the patient breathes quietly. There are no exaggerated excursions of the diaphragm, or increased intra-abdominal pressure, with consequent bobbing about of intestines. We obtain a "silent belly," and this facilitates operative maneuvers, and enables the surgeon to work skilfully and speedily. We have noticed in extensive intestinal resections, resections of the stomach, and in gall-bladder operations that shock is minimized by the use of spinal anæsthesia.

The late untoward results of spinal anæsthesia have been greatly exaggerated. Patients sometimes complain of severe headache after they return from the operating room. If the character of the operation permits the patient to take medicine by mouth we administer 10 grains of aspirin, and sometimes in addition a cupful of black coffee. Otherwise we may resort to morphine. In one patient an internal strabismus developed 3 days after operation, persisted for several weeks, and completely disappeared. About the same time an internal strabismus was observed in one of the medical wards, following a simple spinal tap performed for diagnostic examination. The dangers of spinal anæsthesia, in our opinion, are immediate; the fear of late complications—especially paralysis—may be regarded as a superstitious phobia. In making this statement we assume that the anæsthetic agent is not irritating to the cord or meninges, and the technique of administration beyond reproach.

Spinal anæsthesia usually lasts about 1 hour and 15 minutes; sometimes less (about 45 minutes), and sometimes considerably longer (about 2½ hours). If the operation is expected to last more than an hour we should plan to supplement the spinal by local or general anæsthesia.

One of the contra-indications of spinal anæsthesia is supposed to be low blood pressure. Most of our patients were young men, but nevertheless not uniformly good operative risks. The average blood pressure was 128 systolic and 80 diastolic. We have frequently administered spinal anæsthesia to patients with systolic blood pressures ranging between 90 to 100. It seems safe to accept a systolic blood pressure as low as 100 for spinal anæsthesia, but in the present state of our knowledge and experience this should be the low limit. Some other form of anæsthesia is advised for patients with a systolic blood pressure lower than 100.

Spinal anæsthesia should not be used routinely on all patients; no form of anæsthesia should be used routinely. If we understand how to use spinal anæsthesia, and bear in mind its limitations, we have at our command an excellent form of anæsthesia suitable for a large number of patients. Spinal anæsthesia was first used in this hospital in June, 1924, and since then to February 1, 1927, 1,428 operations were performed, either by the writer or his assistants. Spinal anæsthesia (unsupplemented) was used in 368; spinal, nitrous oxide and ether, 16; spinal and local, 8; local (procaine), 488; caudal, 153; local and nitrous oxide, 29; ether and nitrous oxide, 221; ether, 138; caudal and nitrous oxide, 7.

In the Naval and Military Service and in isolated locations where there is a lack of capable assistants, the surgeon can employ this form of anæsthesia and thereby have his most valuable assistant help him with the operation instead of functioning as the anæsthetist. However, someone should be at the head of the table to cheer the patient, give him a word of encouragement, or engage him in conversation. The patient's general condition should be watched by this assistant, who can also administer appropriate treatment, including intravenous salt solution and adrenalin, as indicated. We do not believe in fussing with patients under spinal anæsthesia. We do not ask them how they feel every few minutes, nor do we note their blood pressure every so often. We determine the blood pressure before and after the injection, and again only when the patient shows symptoms of collapse. We endeavor to

create an air of genial confidence. We try to raise the patient's morale by our words and actions. Spinal and local anæsthesia work best mixed with psychology.

For operations in the upper abdomen we make the injection between the eleventh and twelfth thoracic vertebræ, and for the lower abdomen between the second and third, or third and fourth lumbar vertebræ. We have practically abandoned the high injections and now use spinal anæsthesia only for operations on the lower half of the body. Sometimes the lumbar injection gives anæsthesia throughout the abdomen.

Our technique for the administration of spinal anæsthesia is as follows:

1. Two grains of powdered novocain are placed in a medicine glass or beaker, the top of the container covered with gauze and placed in the autoclave for eight minutes under 15 lbs. pressure.

2. The patient, who has received a preliminary hypodermic injection of morphine and atropine, is placed in the sitting posture if his condition permits, over the side of the table, and the site of the injection painted with tincture of iodine and then with alcohol.

3. An 18 gauge nickeloid spinal needle is introduced in the center line between the second and third or third and fourth lumbar spines, and about 8 cubic centimeters of spinal fluid collected in the beaker containing the sterilized novocain. The stylet is replaced in the bore of the needle to prevent further escape of spinal fluid, while 3 drops of adrenalin are mixed in the beaker, with the spinal fluid and novocain. When the novocain is completely dissolved the contents of the beaker are drawn into a 10 cubic centimeter Luer syringe, the stylet is removed from the needle, and the contents of the syringe are slowly injected.

4. The needle is withdrawn, the site of the puncture touched with collodion, and the patient placed in the recumbent posture with the head slightly elevated.

The patient at first finds his legs heavy when he attempts to raise them, and when this sign appears, we can feel fairly certain satisfactory anæsthesia will be obtained. Anæsthesia usually promptly follows the injection but the operation should not be started for at least 15 minutes after the injection is given.

We do not lower the patient's head, as the solution injected is heavier than plain spinal fluid. After the lapse of 15 or 20 minutes, when anæsthesia has been effected, it appears to make no great difference whether the patient's head is raised or lowered. We have operated with the patient in the Trendelenburg position. We wish to repeat, however, that the patient's head should be kept slightly raised until anæsthesia is obtained. A conscious patient lying on his back is most comfortable, and can breathe easier with his head resting on a small pillow.

1. Spinal anæsthesia does not fulfill all our ideal requirements.

2. It produces excellent relaxation.

3. The intrathecal injection of 2 grains of novocain, dissolved in spinal fluid failed to produce anæsthesia in 2.55 per cent of our cases.

4. Spinal anæsthesia cannot be relied upon for long operations, unless it is supplemented with local or some form of general anæsthesia.

5. Novocain spinal anæsthesia is safe provided the injection is made no higher than the second lumbar interspace.

6. We should constantly remember that patients under spinal anæsthesia are awake and are therefore susceptible to suggestion.

THE LOCAL USE OF ETHER IN GYNECOLOGY[1]

By GEORGE DE TARNOWSKY, M.D., F.A.C.S., Chicago

FOUR years ago next month I presented before the fellows of this society my experience in the use of ether as a method of treatment in peritonitis and allied diseases. At that time, while I had had considerable experience in the local use of ether in infections, I had not had enough gynecological cases to warrant my presenting that part of the subject to you. I want tonight to report the local use of ether in two gynecological conditions, chronic endocervicitis and therapeutic abortion.

I have had the opportunity of treating ten such cases. The age of the patients varied between 18 and 44 years. Two of the patients were married, iii-para and iv-para; four were married and had never been pregnant and four were unmarried. The duration of the endocervicitis varied between a few months and 4 years. Two of the ten had lacerated cervices which were repaired in addition to the local treatment. I used ether in these conditions because I was confident that if we could find some solution which was a stimulant, but which could not produce any deteriorating effects on function, we might show a step in advance in the treatment of chronic endocervicitis or cervicitis. The method advocated is comparatively simple. The whole procedure can be carried out in the office. If you have an assistant or a nurse, it makes it a little easier but it is not necessary. The only instruments needed are a bivalve speculum, an ordinary dressing forceps, a tenaculum, a 20 cubic centimeter glass Luer syringe, and some 12 or 14 gauge rubber catheters. The patient is placed on the gynecological table and the bivalve speculum introduced. The cervix is hooked with the tenaculum to steady it. The tip of the catheter is grasped with the dressing forceps, and under guidance of the eye is pushed into the cervical canal for 1.5 to 2 inches. After this is done the tenaculum and dressing forceps are removed and an ordinary tampon inserted. I prefer cotton to any other material, because it absorbs the few drops of ether liquid which will drop back into the vagina. The Luer syringe is filled with 20 cubic centimeters of ether which is injected through the catheter fairly slowly. The patient who receives approximately 20 cubic centimeters complains of a sensation of cold, followed immediately afterward by a sensation of extreme warmth but she does not complain of severe pain.

In none of the ten cases was there any severe reaction. The object of the cotton tampon is to prevent the dropping of the few drops of liquid ether into the vagina, which would be painful. Consequently by the holding of the tampon tight against the cervix, pressure is maintained. Those of you who were here 4 years ago will remember my stating that the action of ether was the same as that of a vapor. Ten seconds after it is put into the peritoneum, it acts as a vapor under tension. Therefore a tampon placed against the cervix has this double action; it prevents the dropping of ether into the cervix, and permits the vaporization to be more thorough. Following the treatment we wait 5 minutes, and then remove the tampon. The patient leaves the office 5 or 10 minutes later. The treatments are repeated twice a week. It goes without saying that in cases with lacerations and in chronic enlargement of the Bartholin gland, treatment should be surgical prior to that of ether.

The results have been extremely gratifying. Perhaps I could mention one typical case, a young woman, of 21 years, married 4 years, not pregnant. On examination I found a marked retroversion of the uterus and a typical picture of an oozing cervix. There was thick, tenacious mucus filling the whole upper vaginal vault. After eight treatments, the endocervicitis had improved 75 per cent. I did a round ligament shortening and the patient left the hospital after twelve treatments. I followed that patient for 1½ years. She reported to me every 3 months for

[1]Read before the Chicago Gynecological Society, December 17, 1926.

examination. I consider her absolutely cured. The same is true of the two patients with lacerated cervices which I repaired and afterward treated locally. They are absolutely well; do not complain of leucorrhœa and no longer wear protectors. I have no hesitancy in recommending this, as a simple, effective office treatment for endocervicitis.

The second condition in which I have used ether locally, and I hesitate somewhat to present this because it might be misunderstood, is for the production of therapeutic abortion. In the past 5 years I have had three occasions to produce therapeutic abortion. The first was in a young married woman, a Polish refugee, 27 years of age, who was sent to me because of tuberculosis of the left upper lobe of the lung. She had not only a tuberculosis but also a pleurisy with effusion. With the same treatment which I use for endocervicitis I introduced the catheter 4 inches instead of 2 and injected 1 dram of ether into the uterine cavity. The same sensation of cold, followed however in this case by a sensation of heat and immediate cramps, occurred. Within 2 minutes ether vapor mixed with a few drops of blood issued through the cervical canal. I left the patient on the table for 5 minutes, at the end of which time the cramps had ceased. She was taken home and 18 hours later passed a spontaneous product of conception. That was my first case. A year and a half later an Italian woman, also tuberculous, 2½ months pregnant, was sent to me and I used the same treatment. In this case I did not succeed in passing the soft rubber catheter. She had been badly lacerated in the two previous pregnancies and I could not pass the catheter into the orifice. Fortunately, I had a No. 12 Coudé hard catheter, and by holding it with its tip turned anteriorly, it passed into the uterine canal without any difficulty. Again I injected a dram of ether. This patient was a Sicilian, highly excitable, and she created quite a little disturbance in the office for about 2 minutes. The cramps apparently were excessive. She confessed afterward that the pain was not excessive but that she was scared. Those of you who know the southern Italians can understand how they cry out at apparently nothing. She quieted down and was taken home. Twelve hours later she telephoned me that she had expelled a product of conception.

The third case was a Russian refugee, 27 years of age, married, i-para, with a right upper lobe tuberculosis and a pleurisy with effusion. The same procedure was carried out on this third patient and 20 hours later she had a spontaneous expulsion of the products of conception. This third case 8 months later died at the Municipal Tuberculosis Sanitarium of a generalized pulmonary tuberculosis.

I report these three cases because I think they give one a new modus operandi in cases in which therapeutic abortion is frankly indicated. Remember, these cases were charity cases and did not want to go to the hospital, and especially did not want to go to the Cook County Hospital. All three were followed for months afterward and there were no complications in any one of the three. I hesitate to report the method because of the danger of such procedure being abused, but I do feel it is a safe procedure when there are proper indications, and there surely were indications in this particular group.

CÆSAREAN SECTION

Indication and Limitations[1]

By GEORGE CLARK MOSHER, A.M., M.D., F.A.C.S., Kansas City, Missouri

THE primitive indication for abdominal delivery was doubtless the attempt to spare the unborn child of a dying mother. This was a practice among the Egyptians and the Jews, perhaps even with earlier nations, more primitive people.

Cæsarean section was certainly known to the Romans, as witness the lex regia of Numa Pompilius, one of the early Cæsars, that the body of no woman dying in labor should be buried without the child being first extracted. The interest of the mother, of course, was not considered as she was already moribund. The lex regia became the lex cæsarea or law of the Emperor, under the Cæsars; coming down through the Germans as the Kaiserschnitt; thus it was a Royal decree, an edict, not a method of operation.

The derivation of the word is questioned by some authorities as to whether it be from *cædo, cædere, cæsi, cæsum*, or from one of several other roots. If the derivation be accepted as from cædere, to cut, it is clear then cæsarean section is a redundancy, being a duplication of two words of similar meaning. The terminology must probably be left in doubt.

Whatever the derivation, the operation will probably continue to be known by its present designation, since time and custom have stamped it with approval.

The history of the cæsarean operation is to be divided into four periods.

First the postmortem law, the lex regia up to 1500; second 1500 to 1876; third 1876 to 1888; and the fourth since 1888.

Vague tradition doubtless is more than historical fact the source of many stories of the survival of the mother in early sections. It is questioned if Julius Cæsar was thus born, as witness letters he wrote from his various wars to his mother Julia. Several other historical characters including Æsculapius and Edward VI of England were reputed to have been cæsareans. Perhaps they were.

Shakespeare tells us that Macduff was "from his mother's womb untimely ripped"; but Dr. Harris thinks that this has reference to a horn rip by a bull, not by the knife of the barber or lithotomist.

Medical antiquaries have long studied the interesting case of the wife of Jakob Nufer, the sow gelder of Segerhausen, Switzerland, in 1500. The patient was given up in despair by eleven barbers and seven midwives because they saw no indication for her delivery. We are told she was operated upon by the schwein spayer himself, as he declared, *non secus alicui porco*, just like he would do for a sow. However, since Mrs. Nufer lived to bear four other children, including a pair of twins, there is a question as to whether the case was not one of full term abdominal ectopic pregnancy, and not a problem of contracted pelvis, which was thus happily terminated.

It is a far cry from Nufer to the refinement which today is to be seen in a cæsarean section, yet for over 300 years we learn that no improvement in results was obtained in maternal mortality in abdominal delivery. Dr. Harris, of Philadelphia, wrote that until Dr. Lusk's case in 1876, no successful operation, so far as the mother was concerned, had been performed in America in half a century. In fact he gathered statistics of 14 cases of gore ripping by bulls and buffaloes, with 10 mothers and 7 babies surviving, as against 84 per cent death rate of mothers at the hands of the surgeons.

The victims of the cæsarean all died from hæmorrhage and sepsis, as the uterine wound was not sutured.

Tarnier said that no woman who was delivered by a cæsarean in Paris, 1787 to 1876, survived; Winckel and Stein made the same assertion as to the operation in Vienna.

The indication for cæsarean section in the interest of the mother dates from the third period, that of Porro's supravaginal amputa-

[1]Presented before the Detroit Obstetrical Society, October 12, 1926.

tion of the uterus in 1876, the brilliant results of which would seem to justify the performing of the operation as a means of saving the life of the woman, the mortality having been previously 56 to 84 per cent. Hence Porro is to be hailed as the discoverer of a humane and comparatively safe operation, which has been a boon to humanity.

It is an interesting commentary on the third era that Dr. Renkel, a medical missionary in Uganda, Africa, described a cæsarean section which he saw, done by a native in 1879. The patient was made drunk on banana wine, as an anæsthetic. The operator washed his hands in the same fluid, as an antiseptic. The incision was made, the fetus lifted out, the cord was cut, the placenta removed and the uterine cavity washed out with the wine. The abdomen was held together by two native assistants, while the abdominal wound was closed, with a figure of eight of grass on pins. The entire abdomen was then covered with a paste of herbs. The temperature did not rise over 100. The wound was healed in 11 days.

The fourth epoch in cæsarean begins with Saenger, in 1888. This was the first conservative, as compared with Porro's section and amputation of the uterus which was, of course, radical.

Porro's method was then relegated properly to the class of cases distinctly infected, Saenger's operation preserving the maternal capacity of the woman. The present day fourth era includes the conservative section of Saenger, the Porro amputation, the two flap low cervical incision, of De Lee and Beck, following that of Frank of Cologne, in 1907, (extraperitoneal operation for cases infected) and the vaginal cæsarean to which Reuben Peterson, in 1914, gave a most enthusiastic discussion, even urging it as the operative technique for the general practitioner.

Analysis of all the various methods of operation brings the appreciation that each had its virtues in some especial instance; for the great majority of cases the indication will still be the classical conservative operation.

When a previous attempt has been made to deliver by the pelvic route, the membranes being ruptured, when forceps, version or craniotomy have been attempted, or even when repeated vaginal examinations have contaminated the field and infection is to be anticipated, the Saenger conservative operation is not indicated, because of the enormous mortality. The choice under these circumstances is to be dependent on the obstetrical judgment of the attendant.

The outstanding fact to be borne in mind in estimating the true value of cæsarean section is that the perfection of operative technique is not the *sine qua non* in the reduction of mortality. Technique has this marked benefit only in properly selected cases.

Not only among the laity, but of enormously greater gravity, there exists in the minds of the profession today the idea that cæsarean section is an absolutely safe and simple operation, which can always be depended upon to give perfectly satisfactory results to mother and child.

It must be borne in mind that any laparotomy carries its element of the risk, even in the hands of the most skilled operator and under the most ideal condition of the patient and her environment. Hence a cæsarean operation, instead of being chosen as one of election after deliberate consideration as the safest and best means of delivery, is adopted by many poorly trained obstetricians and general surgeons who do not pretend to have a working knowledge of the fundamental principles of the art of obstetrics. It is looked upon as an universal panacea for all obstetric ills, regardless of the condition of the patient, her measurements, her general health or the history of her case; or as one of my confrères in our hospital is fond of saying: "Since a cæsarean section is an operation so easy to perform it is like shooting fish in shallow water." It is the easiest obstetrical maneuver, unless one admits the application of low forceps at the outlet; yet the operation carries with it, because of failure properly and intelligently to interpret indications, a greater morbidity and mortality than any other abdominal operation done for any pelvic condition.

Because of the furore for surgical delivery of the child, cæsarean section has become such a popular operation that we are prone

to forget that the operation is not to be undertaken simply as an example of spectacular brilliant abdominal surgery. It is rather to be approached in a very different spirit; for it is a demonstration of the obstetrical conscience with limitations which yearly become more hard and fast when measured by the risk rate involved on the part of the mother.

It is an established fact that the scope of any surgical procedure widens as the technique is perfected and as the morbidity and mortality are thereby reduced. Cæsarean section has been no exception to this rule.

It is the endeavor of this discussion to show that while the indication has been properly extended and while statistics can be adduced to prove a mortality of 2 per cent, these figures are based on select cases with ideal environment and experienced obstetrical skill in the management of the delivery; on the other hand, in general the records are appalling because surgeons are being urged, by general practitioners, to do section where no indication is manifested, and in cases in which hours before the stage has passed in which the mother could be safely delivered in this manner.

Dr. Rudolph Holmes, of Chicago, gave me in a letter dated April 8, 1926, some most interesting figures bearing on the incidence of cæsarean section. These were gleaned by Dr. Tottenham, a young Irish obstetrician, who in 1925, on his way to assume the chair of professor of obstetrics and gynecology, in the University of Hongkong, China, spent a number of months among American maternity hospitals. The information is, of course, first hand, as it was given by officials of the hospitals, to Dr. Tottenham personally.

The following figures were obtained: In the Jefferson Hospital, Philadelphia, 362 deliveries were done in 1924; 55 by cæsarean section, an incidence of 1 to 6. In the Boston Lying-In, there were 1,123 births, with cæsarean section in 92; an incidence of 1 to 12. In the Bellevue Hospital, New York, in 4,286 births there were 44 cæsarean sections, an incidence 1 to 97. In the New York Lying-In, 3,511 labors with 5 cæsareans, an incidence 1 to 585. In the Johns Hopkins Hospital there were 875 births for the year, with cæsarean section incidence 1 to 125; since the opening of the hospital the incidence has been 1 to 103. In the Swedish Hospital, Minneapolis, in 1,667 births there were 4 cæsarean sections, an incidence 1 to 201. In the Burnside Hospital, Toronto, within 8 years there were 6,982 births, with 8 cæsarean sections, an incidence of 1 to 861.

The interesting fact of these figures is again the obstetrical conscience. The selection of cases for cæsarean section, showing an incidence all the way from 1 to 6 in Jefferson, 1 to 12 in Boston Lying-In, to 1 in 631 in Minneapolis General and 1 in 861 in Toronto, is a remarkable contrast.

Surely the material reaching the maternity hospital in the various sections of the country can hardly show such wide discrepancy in its anatomical or pathological indications. We must recognize that the personal equation is largely responsible for the statistics.

In a study of 2,000 cases of contracted pelvis in the Montreal Maternity 1906 to 1924, out of 15,000 labors, it was found that 622 cases were of the generally contracted type, 509 were rachitic, 398 were masculine, and 18 were diseased. The interesting feature of the analysis is that 75.5 per cent delivered themselves spontaneously, leaving but 24.5 per cent which must be relieved by some operative procedure. Forceps deliveries were done in 186 with 2 deaths; 1 from cardiac disease, 1 from sepsis. The infant death rate was 16.6 per cent. Version and extraction was done in 68 cases with one death from hæmorrhage and with 30.8 per cent infant mortality. Cæsarean section was done 117 times for contracted pelvis, with a maternal mortality of 5: 3 from sepsis, 1 from cardiac disease, and 1 from sarcoma. Seven of the babies were lost. Craniotomy was done 31 times, always by selection, with no maternal deaths.

In 70 cases labor was induced with no maternal death. These results are fairly indicative of a well organized prenatal service and the cases of pelvic dystocia which must come into the class of operative treatment are differentiated long before the case reaches the stage of an emergency; again proving the

immense value to women in labor of having had prenatal care during pregnancy.

Eardley Holland, of Birmingham, in an exhaustive study recently gave the most complete analysis of the risk rate in cæsarean section since that of Peterson in 1914. Holland's survey included all the reported cases of cæsarean section done in Great Britain and Ireland, 1911 to 1920, and his analysis of the indications has become a classic. Included are 4,197 cases of section and they are classified according to the indication: contracted pelvis, 3,372; eclampsia and other toxæmia, 227; antepartum hæmorrhage 208; other conditions, 336.

The mortality in contracted pelvis was 4.1 per cent. The 1,202 cases operated upon before the onset of labor gave a mortality of 1.6 per cent; in 389 sections done early in labor the mortality was 1.8. Operation late in labor showed an increase in a death rate of 10 per cent. In 35 cases a previous attempt at induction before the section was done had failed. The mortality here was 14 per cent. After unsuccessful attempt at forceps delivery, the cæsarean mortality was 25.7 per cent for the mother, and 38 per cent for the fetus; 50 per cent maternal mortality followed unsuccessful attempt at craniotomy.

In the 139 cases of contracted pelvis which resulted fatally, the cause of death was peritonitis, 49; sepsis, 16; septicæmia, 10; pulmonary embolism, 8; pneumonia (all types), 17; ileus, 2; and intestinal obstruction, 3. Of the children, 122 were born dead, and 131 died in the first 2 weeks. The infant deaths were directly proportional to the duration of the labor. The maternal mortality in 195 cases of eclampsia treated by cæsarean section was 32.2 per cent. The death rate was three times higher after the sixth convulsion. Toxæmia was blamed for 20 cases; pneumonia (all types) 8, and embolism 1. Fetal and infant mortality was 50 per cent. Prematurity was assigned as the chief cause of infant death.

For placenta prævia, section was done 139 times with a mortality of 11.5 and a fetal death rate of 27 per cent.

For accidental hæmorrhage, Holland reports a mortality of 27 per cent in 66 cases; uterine disease was given as a cause in 30 cases with a maternal mortality of 46 per cent and fetal mortality 86 per cent.

In hæmorrhage and shock, the operation was done, not primarily to save the child, but as the quickest and easiest means of controlling the hæmorrhage from the fatigued uterus.

Obstruction by fibroids was the indication in 88 cases, and ovarian cysts in 12; carcinoma of the cervix was the indication 25 times. The mortality in fibroids was 10 per cent and fetal death 25 per cent.

Thirty-three cases were operated upon because of malpresentation or over-size of the fetus.

Grave maternal disease included 40 cases with heart trouble, and the mortality in these was 25 per cent with fetal deaths 16 per cent.

Two sections were done for pulmonary tuberculosis, and two for habitual death of the fetus during labor.

Holland does not mention the number of cases of secondary sections done, the indication being a previous abdominal delivery. This report covers only the experience of British obstetric surgery. In a discussion of the subject of operative obstetrics in America Polak recently said: "It has been carried to such an extent that even the physiological process of normal labor is being disturbed; a normal child in normal position, being propelled by normal mechanism of labor, through a pelvis which is ample and with soft parts that are thoroughly dilatable is today often disturbed, either by cæsarean, by version, or routine application of forceps, as soon as the head reaches the ischial spines. Other operators have so widened the indications for cæsarean section that this method is being employed for no real obstetric reason, simply because it is the quickest, most convenient way of getting the baby out of the uterus.

"The average hospital, however, will show a death rate record of 10 per cent and over, while in selected cases under ideal conditions of technique the mortality is less than 2 per cent. This variation between 2 per cent and 10, cannot be all due to difference in

operative ability nor to any other causes than careless and reckless neglect of obstetric principles."

However, Polak has demonstrated that the cæsarean patient has imposed on her, even in a clean case, because of the presence of infective bacteria in the cavity of the uterus a possible infection. These bacteria find their way through the open cervix to the wounded area of the uterus; consequently a morbidity follows which the patient operated upon for a tumor such as a fibroid or ovarian cysts is spared.

These bacteria were found by Polak, later by Losser, on the fifth and sixth day after operation. The sutured wound is invaded as well as the vast culture field which the placental site affords.

In Massachusetts in 1921, cæsarean section had displaced eclampsia as the second most frequent cause of death among parturient women. Surgeons in Massachusetts are surely an average in ability, so it is again apparent that perfection in operative skill is not alone the important factor in reduction of mortality.

Newell reported a survey of hospitals within a radius of 40 miles of Boston, revealing 100 cæsarean sections with 100 per cent mortality; in the majority of these tragedies the fact that cæsarean section had been done did not appear in the report.

In a letter from Dr. William H. Davis, chief statistician for *Vital Statistics of the Census Bureau*, dated April 5, 1926, are the following figures showing that the deaths from cæsarean are increasing in this country year by year. In 1921, 247 deaths were reported in the United States; in 1922, 266; in 1923, 285; and in 1924, 304. While these are doubtless far from correct since many deaths will be reported as from septicæmia, hæmorrhage or other coincident causes, the figures are suggestive as demonstrating the increased recorded mortality of 22 per cent in 4 years!

In the *American Journal of Obstetrics and Diseases of Women and Children*, April 1908, Dr. Halpenny, of Winnipeg, discusses the indications for cæsarean section, and in his conclusions submits a question which he propounded to a number of operators throughout the country, as to sterilization following a cæsarean in a primipara aged 30, with a conjugata of 6.75 centimeters. The answers he received were so varied that one is struck with their lack of harmony, until analysis of the group reveals that it is the state of mind, surgical or obstetrical, which is responsible, for the difference.

Among those consulted were J. Fairbairn Binnie, of Kansas City; William J. Mayo, of Rochester; John B. Murphy, of Chicago; George W. Crile, of Cleveland; John B. Deaver, of Philadelphia, all general surgeons. The obstetricians consulted were J. Whitridge Williams, of Johns Hopkins; Joseph B. DeLee, of Northwestern; J. Clarence Webster, of Rush Medical College; Henry D. Fry, of Georgetown University; and William H. Gardner, Montreal University. The verdict was nearly a 50 per cent hung jury, Webster joining the general surgeons for sterilizing; and Mayo and Deaver agreeing with the obstetricians that the woman should have the opportunity of an attempt to have another child. The views of all operators on such points which are fundamental, need to be crystallized before we can expect to bring ideal results into our statistics.

When one goes back to the first principles of obstetrics he must realize the vast transformation which has taken place and how much the operation of cæsarean section has been popularized throughout the civilized world in the last 10 years. Where section is advantageously employed we all claim results are admirable, but in cases in which it is contra-indicated, it is not only unjustified, but it becomes a factor in heightened morbidity and mortality.

How are we in America to get back to normalcy in this situation? If you will bear with me a few minutes, let us briefly consider a much neglected phase of prenatal care, and that is the simpler measurements of the pelvis. A suspicion of pelvic deformity is aroused by small stature, unusual gait, malformation of spine, or limbs; or in a primipara, by a pendulous abdomen.

However, pelvic malformation may exist unsuspected, with no outward indication.

On the other hand, statistics will prove that in the great majority of cases of pelvic discrepancy, say 75 per cent, the patient will be able to deliver herself without interference. So, one may say that the whole problem of cæsarean section may be included in two phases of maternal welfare, which is after all the very foundation of modern obstetrics: first the obstetric conscience, which one must have to differentiate the normal voluntary case from the one which requires a section either in the interest of the mother or of that of the prospective child; and a second a knowledge of pelvimetry, conscientiously applied.

Familiarity with the diameters of the brim and the outlet are essential and are so very simple; yet how often are they understood in general practice, or how often are they utilized in the every day experience of ordinary management of obstetrics?

I am now pleading with you not only as specialists, but as leaders and teachers of the great body of the profession, and I ask what percentage of our patients come into the labor room who have had a definite chart made which shows the capacity of the passages and the bulk of the passenger? Perhaps not one in a thousand physicians gives any thought to the matter.

The great multitude of women, especially in the South still dependent on midwives, which number is, I believe, estimated at a quarter of a million out of two and one-half million confinements annually in the United States, are not included in a discussion of cæsarean section. Their problems of mortality are in another class. I refer only to those patients who are attended by physicians.

Sooner or later education of the laity will demand that the accoucheur must become familiar with prenatal care, just as women have been taught the safety of the hospital. Every doctor should carry a pelvimeter and a tape, just as he has a thermometer, a hypodermic syringe, a stethoscope, and a blood pressure apparatus. Every woman putting her life in the hands of a doctor in her pregnancy is entitled to have a careful physical examination, routine advice throughout, and close observation, measurements, weight, etc.

If the external measurements are average normal figures, it may not be necessary to go further in the pelvic investigation than the crests, the spines and the Baudelocque or external conjugate. These should be taken and recorded. If these be found equally diminished a generally contracted pelvis is suspected. If the outlet is diminished it may be a funnel pelvis. The pelvimeter is simply a pair of carpenter's calipers, extended and gauged. Any model is good; the most popular comprising that of Baudelocque, the original French pattern, the Martin, the Collyer, the Carstens, and the Breisky. The last has an ingenious device, a small scale for the outlet in addition to the scale for the estimation of the brim and the anteroposterior diameter, two instruments in one.

The myriad internal pelvimeters are of no practical use. That of Skutch or Stein is most frequently seen.

The manual examination is far more satisfactory in obtaining internal diameters.

The true conjugate is to be estimated only from the measurement on the index and middle fingers of the right hand passed into the vagina until the middle finger impinges on the promontory and the forefinger is pressed against the subpubic ligament; the forefinger of the left then marks off the lower margin of the subpubic ligament, on the right. Both hands are then withdrawn with the left forefinger still at the point marked on the right index; the distance is taken by calipers or tape. It is needless to say this should be done carefully; not mistaking a false promontory and not failing to mark off the lower margin of the subpubic ligament exactly.

A discrepancy may be found here, as there is some variation in pelves as to the thickness of the pubic symphysis. Postmortem examinations have shown an error as great as 2 centimeters.

In estimating the true conjugate from the oblique, one must consider (1) the depth of the symphysis, (2) the height of the promontory, and (3) the angle of the symphysis to the horizon.

An old method of manual estimation of the depth of the pelvis described by Johnston,

of Edinburgh, was done by passing the whole hand into the vagina, a procedure not to be commended in a refined twentieth century practice. This maneuver might give a skilled obstetrician some idea of the pelvic formation, but in a primipara, without an anæsthetic, it would be inconceivable.

It is obvious that all measurements are only approximate. The accuracy of any plan of examination can only be approximate to within 0.6 centimeters. This for all practical purposes is sufficient in the general run of cases.

Another element to be considered in pelvimetry is the passenger. To determine the question of method of delivery, one must estimate the size of the head of the fetus, the head, of course, being the usual obstacle if dystocia be encountered from the direction of the child. A student of eugenics will at once visualize the fetus when he sees the two parents. He will form some idea of the size and shape of the head of the baby estimated from the father and mother—only a vague surmise but a suggestion.

A number of expedients have been proposed to measure the head *in utero*, but they have not been found successful. One cannot calculate the degree of ossification, nor the more important element, the consistency of the cranium and its compressibility which are dependent on sutures and fontanelles.

So we deal with some degree of uncertainty regarding both the birth canal and the oncoming head. This led Barbour to say that the fetal head is itself the best pelvimeter, because either head or pelvis may be abnormal in a given case. There must be distinct adaptation to insure voluntary delivery.

In measuring the head Kerr's manual method is far more satisfactory than Perret's cephalometer. Kerr passes the left hand into the vagina. With the right hand he grasps the head suprapubic and presses it into the superior strait. The manner of engagement at the brim can be estimated, also the consistency of the head, and by pressing the thumb along the brim, the degree of overlapping can be found.

By this simple maneuver one may quickly determine the indication for (1) voluntary delivery; (2) forceps; or (3) cæsarean section.

It is needless to say all this examination should be done and information obtained at least a month before delivery. No vaginal examination should be permitted within the limit of a week, regardless of what aseptic precautions have been observed.

One establishes a general rule that cæsarean section is always the choice for a live child and craniotomy for a dead one, if these come into competition. The exception is met when a case of extreme pelvic deformity (less than 6 centimeters of a true conjugate) is encountered. In this case the body of the fetus cannot be dragged through the pelvic outlet, regardless of skill or experience. It is an anatomical and physical *impasse*.

In establishing an absolute indication for cæsarean, it would include deformity of 6 centimeters true conjugate and solid tumors in the pelvis, which form an absolute barrier to progress.

The relative indications recognized include (1) pelves with true conjugate between 7.5 and 9 centimeters; (2) tumors, fibromata or ovarian cysts; (3) placenta prævia; (4) eclampsia; (5) ventral fixation; (6) prolapse of cord; (7) impacted shoulder (fetal mortality is 50 per cent even after the section); (8) abnormal condition of the fetus; (9) retraction and contraction rings; (10) scar tissue causing rigid cervix; (11) serious condition of the mother, such as cardiac disease and advanced pulmonary tuberculosis; extreme œdema of the vulva.

When an indication exists postmortem cæsarean section should always be done in case of a dying mother.

To analyze the indications one may say that with a Baudelocque of 17.5 centimeters, a fetus may usually be delivered by the normal passage provided there is no fetal overgrowth. If the oblique conjugate is 10.5 centimeters the true conjugate should be estimated as being 8.5 or 9 centimeters.

We have for a number of years taken McDonald's and Ahlfeld's external measurements for estimating the fetus *in utero*, and with us it has been of much approximate value in determining the size and weight of the child. If the McDonald dimension is checked

by that of Ahlfeld, and an endeavor to measure the accommodation of the head to the inlet by Perrett or Barbour's maneuver is made, one is fairly safe in predicting a voluntary or at the farthest a forceps extraction.

On the other hand if the head does not approximate the capacity of the inlet and we find the true conjugate less than 7.5 and on the other hand the McDonald is over 37 centimeters, or the Ahlfeld over 28 centimeters, one should consider the advisability of a section at the onset of labor. Above 9.5 centimeters of a conjugata vera no trouble need be anticipated from contracted pelvis.

The funnel pelvis which has a bi-ischial diameter of less than 7 centimeters is usually a barrier to normal delivery at the outlet, even if the inlet be capacious.

Cæsarean section is indicated in the presence of tumors if they are a definite interference. Dickinson gathered statistics from which he estimated that in New York State alone there are 350,000 women with fibroids. The majority of these women are not aware of their condition. If they become pregnant they deliver themselves voluntarily.

There must be a positive dystocia to justify an operative delivery in case of fibroids, a fact which I attempted to prove in a paper read at the meeting of the American Association of Obstetricians, Gynecologists, and Abdominal Surgeons at Hot Springs, Virginia. If the myoma be located in the fundus it is not an indication for interference. An incarcerated ovarian cyst with a twisted pedicle demands operative delivery of the child.

In regard to placenta prævia as an indication for cæsarean section, a letter from Dr. J. Whitridge Williams, dated April 14, 1926, gives his views with which my own experience coincides, that is, that it is the rare case in which cæsarean section is indicated for placenta prævia; one with a rigid cervix undilated and a complete central prævia.

In general in my hands the Voorhees bag has served most admirably to plug the cervix and to press against a marginal prævia until a sufficient dilatation is obtained to do a version and extraction. Williams gives a history of 40 cases treated at Johns Hopkins Hospital with bag induction with only one death. Whitehouse in the *Journal of Obstetrics and Gynecology of the British Empire*, also follows the same technique. His experience in the Birmingham Hospital included 211 cases treated by version which resulted in a maternal mortality of 4.2 per cent and a fetal mortality of 91 per cent. Thirty-five cases by the bag method had no maternal death, a fetal mortality of 75 per cent. The cæsarean section he claims is indicated only when symptoms arise after the eighth month, and it is assumed the initial hæmorrhage has not impaired the child's vitality.

Kerr considers that cæsarean section is indicated for central placenta prævia. His figures being 10 per cent maternal and 15 per cent fetal mortality; while the older methods showed 4 per cent maternal and 40 per cent fetal mortality.

As an indication in eclampsia, it was the consensus of opinion at the British Congress of Obstetrics and Gynecology in 1922, that only a case with no labor, a long hard cervix, no progress in 6 hours of conservative treatment, should be sectioned.

Considerable doubt has arisen in the last few years as to the curative effect of rapid delivery in eclampsia as contrasted with conservative methods.

It is in eclampsia, indeed, that cæsarean section suffers its most glaring abuse. The consensus of opinion among competent obstetricians is that the mortality, averaging over 30 per cent, is too high a penalty to pay, in the face of results, by purely obstetrical measures, which have never been approached by those of abdominal section.

The only instance in which the toxæmic patient should be subjected to the added risk of a section is the case of the primipara with unyielding cervix, who has a pre-clamptic history, whose condition suddenly becomes grave, and whose symptoms are not relieved by venesection, veratrum nor morphine, after 6 hours.

In Reuben Peterson's conclusion as to the treatment of eclampsia by cæsarean section he divides the cases into two groups to be visualized for study: first those undertaken before 1908, when the technique test of 12 hours'

labor resulted in 11.2 per cent mortality because of delay; and second those since 1908, in which operation by election has reduced the mortality to a percentage of 6.1.

In his contrast of results of treatment by radical measures, Williams reports a mortality of 24 per cent in radical operative procedure in eclampsia, as against 13 per cent in the Stroganoff series and 10.5 per cent by the Dublin method.

Ventral fixation is today not so popular a gynecological method as it was a few years ago, so it is not so likely to be presented as an indication for cæsarean section, though two cases were seen last year in which dystocia was due to this cause. Williams says that the anterior wall of the uterus buckled in one of his cases in which the junction was effected; the head in one compartment, the feet in the other, thus necessitating a cæsarean section.

There is ordinarily no indication in my opinion for cæsarean section in prolapsed cord, impacted shoulder, posterior position, nor impacted breech unless in a very exceptional condition. Persistent Bandl ring retraction is a legitimate indication.

Too little discussion is apparent in reference to the dictum: "once a cæsarean always a cæsarean."

While in 1924, I fortunately was able to deliver 3 patients by orthodox method, *per via naturalis*, subsequent to a primary section, the exhibit of Dr. Hillis, at the Cook County Hospital, Chicago, of four ruptured uteri occurring in the service between March and September, convinces one that any case may be one of the 4 per cent, which is the universally accepted figure as to frequency of rupture of the uterine scar in a subsequent pregnancy.

Many of these ruptures have occurred previous to labor, thus emphasizing the necessity of elaborate attention to the technique of suturing the uterus following the operation of section, and especially of accurate information as to infection following the cæsarean section.

One cannot rest from a discussion of this sort without calling attention again to the reports of Polak, in Brooklyn, in which he contrasted the mortality of the cases operated upon by election, followed by a maternal mortality of 2 per cent, and those brought in from outside the hospital, potentially infected, with a mortality of 6 per cent; and those frankly infected before admission, in which the mortality was 11 per cent.

No apology is made for this discussion of this subject, since the abuses which have crept into its performance have become such a glaring matter for criticism. The whole question is again one of education. If we can convince ourselves of the proper indications for cæsarean section, that they are definite and that the violation of the recognized limitation will surely be punished, we shall become better obstetricians and the patients will be saved the risk which it is needless to attempt to emphasize, and which they are forced to take, with results which outrage the obstetrical conscience as well as the principles of good surgery.

The absolute contra-indication for cæsarean section is a case in which the child is dead or seriously threatened with danger of dying. If the mother is infected, or in an environment which renders an aseptic operation impracticable, craniotomy should be the operation of choice. However repugnant the destruction of the child may be, it is a matter of expediency to be met, but the woman alive and perhaps already a mother, is of more value to the family and to the state than the unborn fetus which has all the vicissitudes of infancy and childhood to encounter. This is not the teaching of the church but in fact it is the position one must assume who realizes the gravity of his responsibility at a time when prompt and clear thinking are of such paramount importance in reaching a conclusion.

Of course no such decision can be acted upon without consultation and a careful explanation to the family of the risk involved. If it is deemed, after free discussion, that the child is to be spared, regardless of risk, the uterus should be removed at once, after the delivery. Several Kansas City general surgeons have for years had a rule that they will not operate on a case brought in for a cæsarean section without having consultation with an obstetrician.

This gives an experienced opinion as to the general problem: "Is there a physical indication for interference?" Also in the light of our knowledge of results in "late cæsareans" after hours in labor, repeated vaginal examinations, ruptured membranes, attempts at forceps, versions and other procedures, it is apparent that the woman is almost certainly condemned to death if a cæsarean section is done under any of these untoward circumstances. We spare her this risk even if the alternative must be a craniotomy.

A case illustrating the trend of the modern surgical mind occurred recently when a very competent general surgeon, asked that I be called, after two general practitioners had the patient draped and ready for him to perform a cæsarean section, on account of the failure to deliver a large child, in posterior position. No pelvimetry had been done and the woman had been 24 hours in labor and the membranes were ruptured, before she entered the hospital.

I took the external diameters which seemed ample; found the dilatation complete, was able to do an easy version and fortunately both mother and child made an uninterrupted recovery. I assured them it was only good obstetrics.

This case is only mentioned to show that morbidity and mortality in these cases are dependent on obstetrical judgment far more than on the operative skill of the surgeon of recognized skill and ability. We must admit that an operation which carries an average death rate of 10 per cent has something wrong which demands investigation.

Unfortunately, these cases are not segregated but are scattered throughout the country and do not excite the apprehension which would follow were the patients under the care of one operator or a group of surgeons.

A very good suggestion comes from Dr. deNormandie, of Boston, who says that in the operating rooms of one of the hospitals in Massachusetts there were posted notices that no section should be done without consultation. This followed 3 deaths which occurred in succession under care of one operator.

Publicity is a wholesome sedative to the enthusiasm for operation which will not harm any clinic, and may be one source of benefit in reducing our mortality in cæsarean section. Dr. deNormandie remarks that no man likes to have aired his bad results before a group of confrères.

In regard to the question of indication from the standpoint of the patient's relative safety in the choice of procedure, it must be emphasized that it is only when a cæsarean operation is an elective one, done at an appointed hour, just before or just after the onset of labor, for a definite obstetrical indication, that results under these circumstances are beyond reproach. However when, as it is too often the case, it is an emergency section, which is done in neglected labor by an occasional operator, the mortality promptly climbs to appalling heights.

CONCLUSIONS

The indications for cæsarean section may be thus condensed.

1. A Baudelocque of less than 17 centimeters and a true conjugate of 6 centimeters or a tumor blocking the outlet is a positive indication.

2. Seventy-five per cent of all pelvic contractions allow delivery by natural passages.

3. The classical conservative or Saenger operation done when indicated by election is comparatively safe. The mortality should not exceed 2 per cent for the mother.

4. Maternal mortality is increased by leaps and bounds through rupture of the membranes, attempt at forceps, induction, version, craniotomy or even frequent examinations *per vaginam*, previous to the section. After any of these have occurred craniotomy should be selected in the interest of the mother's life.

If a section is done after potential infection it must be a Porro or a low extraperitoneal operation.

5. In eclampsia the indication for cæsarean section is limited to the cases of a primipara with rigid long unyielding cervix, no improvement following 6 hours of conservative treatment.

6. Placenta prævia is most generally an indication for Voorhees bag induction, the exception being severe bleeding with no dilatation in a prævia centralis.

7. Fetal mortality is to be reckoned according to whether the section be demanded by pelvic dystocia or by maternal disease. In the former a minimum death rate for the infant may be predicted. In the latter the risk to the child due to hæmorrhage, toxæmia, or prematurity is necessarily vastly augmented.

Finally, the indication for cæsarean section when we have reached utopia will be entirely dependent on prenatal care and the obstetrical conscience.

FUNDAMENTAL TRAINING FOR OBSTETRICAL NURSES[1]

By GEORGE W. KOSMAK, M.D., F.A.C.S., New York

DURING recent years much has been spoken and written on the nursing situation and the impression has grown that a lack of co-operation and co-ordination exists between organized nurses and the medical profession. In addition, the quasi-political nursing bureaus of various states have, by rapid stages, developed an autocratic control over hospital training schools which has in many instances curtailed their efficiency and engendered a feeling of resentment and antagonism among physicians. This feeling has found expression among organized medical bodies in various ways, from the adoption of protesting resolutions to the formation of committees to study the subject and propose remedies. It is not within my province to enter into a lengthy discussion and argument over these various phases of the changing nursing problem, but merely to refer to them in passing, while considering the particular interest of our Society in the education of obstetrical nurses.

The conception of nursing held up to the time of Florence Nightingale and, indeed, until the beginning of this century, has been superseded after a comparatively rapid development by another view, which has placed this former assistant of the doctor in practically a separate and distinct category. As the opportunities for the practice of the nursing profession increased, so the desire for independence likewise became a prominent feature in this development. Legislative enactments in various states have created a class of "registered nurses," in a fashion similar to that which obtains for physicians, and the public's conception of a "trained nurse" is no longer the legal one.

In former years, hospitals undoubtedly exploited their nursing staffs for their own benefit and it is quite natural that a resentment against such abuses should develop. Nurses have banded themselves together into organizations for their own well-being and have, in addition, aided in the development of a system of nurse training which should be of equal benefit to the practitioners of this profession, and to medical men and their patients. Unfortunately, however, the trend has been away from medical supervision, strictly speaking, in the conduct and organization of nurse training schools and has become largely a matter of lay direction. Moreover, during the last 25 years the education of nurses has drifted strongly toward the acquiring of medical knowledge rather than nursing technique. Undoubtedly, an intelligent nurse should have a knowledge of elementary medicine, or medical facts, in order properly to appreciate nursing procedures. A survey of the curricula, however, leads to the observation that more medicine and less nursing has resulted from the effort. Just how much the medical profession itself is to blame for the unrestrained expansion of higher nurse training is a question not to be settled off-hand. Medicine of today, in certain of its phases, requires a personnel which should be trained in accord with these demands. In other words, we need women to fill newly created positions in social welfare work, in schools, in maternity and child welfare centers, and in a number of other fields.

[1]Read at the fifty-second annual meeting of the American Gynecological Society, Hot Springs, Virginia, May 24, 1927.

It would appear, however, as if the ambition to occupy these higher planes had resulted in a greatly diminished desire to care for sick people in ordinary illnesses.

The diversions of opinion which have developed during recent years as to what should, and what should not, comprise nurse training has led to bitter quarrels and recriminations which have buried the true facts in the question. We hear much about over-trained nurses, just as we hear about over-trained doctors; we are constantly importuned for greater nurse training facilities; the dictation of our quasi-political nurses' organizations is gradually becoming a nuisance, and in some cases a scandal. The question remains, what shall be done to adjust this situation? How shall we bring the doctor and the nurse to a realization of the proper limits of this important activity? And how shall both sides be accorded satisfactory participation, so that the great public, which, in the end, pays the bill, shall not be neglected?

There are several features, economic and otherwise, connected with the development of nursing as we find it today, which must be taken into consideration in discussing the so-called nurse problem. It would require more time than can be allotted to this discussion to take up all of these. It is my purpose not to include any of the extraneous aspects of the question but to limit my remarks to the curriculum or course of study, in the belief that an association of specialists such as this is at least in a position to propose what shall be included in a nurse's training, with particular reference to the field covered by its activities, namely, obstetrics and gynecology. Of these two, obstetrics stands by itself, for most of the elements of gynecological nursing are similar to those of general surgical nursing.

In practically all of the states of the Union, centralized bureaus for the direction of nurse training have been established. Their individual requirements for training are based largely on a standardized curriculum developed by a Committee on Education of the National League of Nursing Education. The first edition of this curriculum was published in 1919 and the sixth edition has recently appeared. Its main objective is to help in raising the general standards in teaching and to secure greater uniformity in the curriculum of nursing schools throughout the country. A so-called basic course is proposed and a careful division of hours and subjects is presented to include a course of training of either 28 or 36 months. This curriculum has been largely developed by a committee of nurses. One of its most striking features is an almost equal division of hours in medicine and the technique of nursing. It is interesting to note what this committee believes to be the practical objective in nursing education and then compare it with the result. A nurse is stated to "belong to one of several professional groups within the general field of medicine and shares with them in the effort to care for the sick, to cure disease, to prevent suffering, and to promote a high standard of health both in individual and in community life." The nurse's service is claimed to be both a personal and a community service and her duties and responsibilities have been theoretically grouped as they relate to the patient, the hospital, the physician, the household, the community, the nursing profession, and finally herself.

One of the statements which strike the reader as possibly a basis for some of the prevalent discontent is that "the nurse does not exist to aid the physician, but both exist to promote the best welfare of the public." In other words, an entire change has taken place in the attitude between the nurse and physician as it was formerly believed to exist, and we are no longer privileged to speak of the nurse as the handmaiden or assistant of a doctor. In the words of a prominent nurse educator, a "nurse exists not primarily to serve the physician, but to serve the individual and the community, and to protect and conserve life in both sick and well."

In view of the limitations of the nursing field as generally viewed by the medical profession, has there not been developed as a result of a lack of interest on our part, or possibly for other reasons, a calling which is no longer in harmony with the practitioner of medicine? In this connection attention may be called to another statement in the "Standard Curriculum," given in answer to the contention

of those who are concerned mainly in increasing the supply of bedside nurses, and believe that the basic course should deal with sick nursing only, while all preventive and social aspects of nursing should be considered as belonging to the specialized field of public health nursing and relegated to a period of postgraduate training. It is quite evident, however, that this is not the opinion held by the majority of nurses, or rather by the League of Nursing Education, which, on the contrary, considered public health nursing just as fundamental as bedside nursing and the prevention of disease at least as important a function of the nurse as the care of the sick.

In order to accomplish these ends it is possible that standards have been developed which do not meet the needs of either the medical profession or the public. This may well be compared to a method of teaching medical students, in which the elementary facts of medicine are side-tracked and importance given to training in the specialties and laboratory procedures. Perhaps we have erred in this respect in our medical schools and probably this would account for the lack of general practitioners and physicians of the old school, men who were able to diagnose disease without laboratory aid and treat it in its ordinary manifestations. It must be recognized that specialists had better be developed by methods which are applied after the basic training in medicine has been secured. It is the narrow field of specialism which in our own branch has resulted in the contracted viewpoint that is of doubtful value to the profession itself and certainly to the community. Shall we sit idly by and permit an allied field of medical activity which depends, or should depend, entirely on the medical profession, to develop at a tangent where elementals are no longer considered of importance and where the ambition of every graduate is not to be an agent for the care of the sick, but to take up public health nursing, or similar independent activity?

In order to present the present status of nursing education in obstetrics, a careful study was made of the curriculum prepared by the National League of Nursing Education, the curriculum of the New York State Nursing Department, and a large number of textbooks intended for the instruction of nurses. It is not necessary at this point to take up the general scheme of instruction except to note that during the first term of 15 weeks, 22 hours are to be devoted to class and laboratory work; 16 hours to practical work in the wards, and 22 hours for study. In the second half of the first year the class in laboratory work is reduced to 12, the practical work increased to 36, and the study hours reduced to 12. In the second year the weekly schedule includes 6 hours in lectures and in class, 48 hours in practical work and 6 hours of study. In the third year the schedule of the second year is repeated.

Let us examine somewhat more closely the curriculum of obstetrical nursing. The total time allotted is 30 hours of lectures and demonstrations in a total of 3 months' service. The instruction includes 10 hours of lectures by an obstetrician and 20 hours of classes by instructors. The lectures include the history and scope of obstetrics, with the basic factors in anatomy of the female pelvis and generative organs, embryology, the physiology and hygiene of normal pregnancy, the complications and accidents of pregnancy, the toxæmias of pregnancy, normal labor, obstetrical operations and complicated labors, normal puerperium, complications of the puerperium, and the normal baby and its care. These lectures are interspersed with the classroom work and ward demonstrations on the technique of obstetrical nursing.

All of this seems quite simple and *à propos* of what we would expect of a nurse as regards a knowledge of elementary obstetrics and the care of the obstetrical patient. Apparently this allots one-third of the nurse's time to obstetrical theory and two-thirds to nursing technique in addition to practical ward attendance. But as a matter of fact we frequently find that the examination papers, both in the hospital and in the State Board tests, are based not on the elementary obstetrics that would apply to nursing procedures. Rather, they are of such a character as would make it difficult for the average, recently graduated physician to pass them in applying for a license to practice.

Obstetrical nursing must be regarded as a very important branch of the nursing curriculum. A large number of nurses should be required by the community in this field. For this reason it would appear logical to assign as much as, if not more, time to this than to any other branch. But we find this is not the case, and psychology, for example, is given just as many hours in the course as obstetrics. The subject is too extended for comment at this point, but a reference to the Standard Curriculum on page 151, of the sixth edition, will fully explain my point. I have no desire to deride or to ridicule, great as the temptation may be. Nor shall I question the value, to a nurse, of the James-Lange theory, the knowledge of the "learned and unlearned S. R. Bonds," the ability to apply the law of associate shifting, or a proficiency in recording all these things in curves and graphs. But I do ask whether 30 hours of these studies with equal credit at examination time as would be secured from the obstetrical course, is a fair and justifiable arrangement? Whether a scientific knowledge of psychology is more essential for a nurse than a medical student, may be a matter of opinion. It all amounts to knowing how to think straight, or more plainly speaking, how to exercise common sense, and I question whether the majority of women who take up nurse training can ever be taught the latter in a class-room or a laboratory. Contact with patients, contact with hospital practice and routine, competition with her fellow students and drill, drill and more drill, will develop initiative, skill, kindness, aptitude, and the ability to handle her patients more than the required 30 hours of psychology in the class-room and poring over text and reference books. And there is likewise another 30-hour period in the basic nurse training course devoted to psychiatric nursing, and 30 hours to the ethics and history of nursing, and 30 hours to modern social and health nursing, —all very interesting perhaps, but of what use to a bedside nurse in the care of a sick patient? I believe that the curriculum generally accepted as a standard is unbalanced, because it does not bring into the foreground the essentials of what a nurse ought to know, on the contrary it clouds the important elementary knowledge by a top-heavy superstructure of non-essentials which takes away from the nurse the understanding and consciousness of her proper position in the field of medicine.

The defense of the newer aspects of nursing has been set forth in many books and magazine articles, and particular attention attaches among others to a collection of essays by Miss M. A. Nutting.[1] Here one is impressed by the high ideals of the author for her profession, ideals that are constantly reiterated, ideals, however, which seem to incline toward the so-called higher education of nurses and less toward what we as physicians regard as the proper and chief functions of a nurse, namely, the care of the sick. This book by Miss Nutting should be widely read by physicians in order to obtain a conception of the tendencies of modern nurse training, of which, according to the author, there are four great branches, teaching, administration work in training schools and hospitals, public health work, and finally private practice. Every other activity except the latter is stressed and the clarion call is for better educated women to go into nursing for the sake of the opportunities in public health and social welfare work. These higher ideals of what must still be regarded as a comparatively modern profession are beautifully expressed, but one becomes somewhat sceptical of a structure which scarcely serves its original purposes. The impression that one gains from a reading of such books and articles is of a desire for something which is not nursing in the accepted sense, but rather an essay into medicine. And so we find in the teaching curriculum that a great deal of stress is laid on methods of preventing disease, on treatment, on public sanitation, on a variety of similar topics which should be a part of the equipment of a medical student and a physician; likewise many of the reference books noted for supplementary reading are those essentially intended for the training of doctors.

One can have no quarrel with the desire of the leaders of the nursing profession if their ideals tend to the elevation of their associates. It is possible that modern medicine

[1] A Sound Economic Basis for Schools of Nursing and Other Addresses. New York: G. P. Putnam's Sons, 1926.

demands a class of practitioners who are not physicians but can fulfill certain tasks that are the developments of the present day. But, has this not resulted in lowering in the estimation of the pupil nurse, the importance of nursing sick people? Will it not be necessary for us to dignify a basic training course as the high ideal of the nursing profession, rather than to make it a stepping-stone for the more advanced branches which now seem to fill the picture? I believe that an organization such as the American Gynecological Society should stamp with its approval a curriculum in obstetrics for example, which will fill the need for trained women in this important branch of nursing and for that purpose a course of training in which the essential is service rather than technical knowledge of a medical character.

In proposing the accompanying syllabus as a part of basic nurse training in obstetrics, due apology must be made for its brevity, as it is merely intended as an outline for a more complete manual of lectures and demonstrations possibly fostered by this Society.

The teaching of obstetrics should be limited to such things as are directly necessary in order to care intelligently for an obstetrical patient. Obstetrics should be taught by a physician who must have in mind the needs of the nurse and not the needs of the medical student. The demonstrations should be conducted by qualified nurse demonstrators, who must arrange their work in accordance with the theoretical lectures in so far as this can be done. In acquainting nurses, for example, with the anatomy of the female generative tract, the fact should be borne in mind that this knowledge should be intimately related to nursing processes. For example, the location of the urinary meatus is more important than a knowledge of the histology of this organ; the position of the uterus and adnexa and their participation in the gestational processes is more important than a knowledge of the structure of the endometrium and the graafian follicles; the relation of the rectum to the vagina is more important than a knowledge of the blood supply and innervation of this structure; what to do in a case of prolapsed cord is more essential than a knowledge of the fetal circulation and the changes which take place at the time of birth. Similar instances might be multiplied. It is essential that a nurse be kept in contact with delivery room practices and thoroughly informed on how to count the fetal heart, how to recognize the various kinds of pains, how to diagnose rupture of the membranes, how to note the symptoms of an impending toxæmia, how to recognize the onset of a septic process. Above all, she must be taught not to assume responsibility, particularly in the face of doubtful symptoms, but to transfer this responsibility to the attending physician. The basic training of a nurse should be divided in such a manner that she is not kept at one task for an unreasonable length of time and the proper balancing of her training in this field consequently neglected.

In proposing the following condensed syllabus of theoretical and practical teaching, the set period of 30 hours as a minimum has been adhered to, although neither the lectures nor the demonstrations may take up the full number. This will afford time for review lectures and for quizzes on the practical demonstrations. The textbooks on obstetrical nursing which have been thus far recommended, should either be supplemented by simpler editions or subjected to revision in which the essentials treated in the lectures are noted and stressed. Moreover, it is of great importance that medical men lecturing to nurses on obstetrics be thoroughly instructed as to the character and purpose of their lectures, that such lectures be given by the attending staff, preferably the seniors, rather than by the resident internes.

With these thoughts in mind, the following syllabus of obstetrical lectures is suggested:

1. *Anatomy as related to obstetrics.* Bony pelvis—general structure, integral part of birth canal, influence of labor. Organs of generation—uterus, ovaries, tubes, vagina, vulva. Relations of vagina, rectum, and bladder. Breasts. Elementary physiology.

2. *Physiology of reproduction and pregnancy.* Menstrual life, puberty to menopause. Embryonic development, impregnated ovum to full term fetus. Fetal membranes, liquor amnii, placenta, cord. Relation of mother to fetus, maternal impressions.

3. *Necessity of prenatal care.* What does this include? Hygiene of pregnancy, diet, clothing, exercise.

4. *Pathology of pregnancy.* Nausea and vomiting—degree, treatment. Interruptions of pregnancy, abortion and premature labor, accidental hæmorrhage, placenta prævia, etc. Intercurrent diseases, heart, lungs, kidneys, exanthemata, grippe.

5. *Toxæmias, early and late.* Causes, varieties, treatment.

6. *Labor.* General features, stages, pains, mechanism, presentation, progress, delivery of baby and placenta. Analgesia, anæsthetics.

7. *Puerperal period.* Involution of uterus, lochia, care of breasts, subinvolution, pyelitis, phlebitis, puerperal mania, sepsis.

8. *Complications.* Prolapsed cord or extremity, hæmorrhage, precipitate labor. Operations,—forceps, version, cæsarean section, induction of labor, perineal and cervical repair.

9. *Newborn infant.* Care, feeding, intercurrent diseases, premature infants.

10. *Quiz.*

Practical demonstrations. Each of these should be extended through 2 hours and be followed by quiz.

1. Anatomy. 2. Hygiene of normal pregnancy. 3. Care of abnormal pregnancy. 4. Preparations for labor, normal. 5. Preparations for labor, abnormal. 6. Puerperal care in normal case. 7. Care of puerperium, abnormal. 8. Complications of pregnancy. 9. Care of toxæmias. 10. Care of newborn.

It is not now possible to present in detail more than the foregoing syllabus of lectures and demonstrations in obstetrics, but it would seem that the American Gynecological Society could well develop through the agency of a committee, or otherwise, a compendium or manual of obstetrical nurse training, working in conjunction with a selected group of nurses for the consideration of the more strictly technical phases of the subject. The lectures in obstetrics should be plainly outlined and I feel that if published, this would serve as a basis for the training of nurses in this branch which would bear the stamp of authority and constitute a guide for those medical men and nurse instructors concerned directly with the teaching of the subject. The many textbooks on obstetrical nursing,—and their number is legion, are not, I believe, suitable for the nurse. Ordinarily they fail to stress the facts that are essential in her training. For example, in a rather well known manual, the general subject of obstetrical operations is suitably presented, but is followed by the detailed technique of various obstetrical procedures, including the steps of a cæsarean operation with its indications, and a full account of the manner in which the uterus must be sutured. Why burden the mind of a nurse with information of this character and not have her well grounded in what to do for an acute obstetrical hæmorrhage, or a fissured nipple.

Much has been said by certain leaders in the nursing profession about the lack of endowment for nurse training and about the hospital work which is done by pupil nurses whose services are supposed to cover the expense of instruction. This is true to a certain extent and no doubt the nurse has been exploited by the hospital. Nevertheless in this connection one may call attention to the fact that at the present time, nurse training constitutes a constantly increasing item in the hospital budget, what with directors and assistant directors, nurse instructors and head supervisors, elaborate housing and recreation facilities and equipment, with laboratories,—chemical, bacteriological, etc. And remember that this training is not only for nurses who are to take care of sick people but also for the production of social welfare workers and other classes of nurse practitioners from whom the hospital gets little or no benefit. Also we must not lose sight of the fact that a hospital must serve likewise for the education of physicians whose hours of attendance as members of the house staff are much longer and more irregular than those of the nurses, and for whose comfort only essentials are ordinarily provided.

The remarkably rapid growth of a variety of social welfare movements in this country during recent years, has called for many nurses as active participants. In the obstetric field in particular the advent of the prenatal clinic and the extensive maternal welfare

agencies developed by the Shepard-Towner measure, have called for a large number of nurses, to whom are delegated many administrative and often strictly medical functions. For these purposes we require more than our basic course and special facilities should be provided such as the post-graduate courses furnished by the Maternity Center of New York and similar organizations.

The countrywide agitation over the nurse problem calls for constructive action on the part of the medical profession. Some progress can be made when organized bodies, such as this Society, will actually propose what they deem necessary in nurse training, after suitable conference with representatives of the officially recognized nursing organizations. There should be closer co-operation, and the guiding hand of the physician should be more manifest in the training of nurses than has been the case in the past. In addition, there are many strictly medical duties that should not be relegated to nurses, especially in certain welfare activities. It is not just to the public to do this, it is not fair to the nurses themselves as they have not been properly trained to carry out many of the functions which are now relegated to them.

We have heard in recent years a great many disagreeable and condemnatory things about the nurse by members of the medical profession, but very little of constructive suggestion has been advanced from the same source. In order to assist in a solution of this problem of nurse education and administration, it is essential above all else that a proper balance be developed. This will require closer co-operation and supervision by the medical profession of nurse training. Those who require the services of a nurse must state what the requirements shall be and I propose herewith that the obstetricians begin by stating what they think is needed and let other classes of practitioners follow their example. Then we will have made a beginning at least in so far as basic training is concerned and the difficulties of licensing, administration, etc., can be taken up and studied in turn as part of the general subject, with less working at cross purposes than is now the case.

CLINICAL SURGERY

FROM THE CLEVELAND CLINIC

TECHNIQUE FOR REMOVING STONES FROM THE UPPER URINARY TRACT

By W. E. LOWER, M.D., F.A.C.S., Cleveland, Ohio

STONES should be removed from the ureter, kidney, pelvis, and calyces with the least possible damage to the structure involved. When the stones are in the lower end of the ureter, manipulation through a cystoscope will often succeed, but a too prolonged attempt may cause considerable traumatism to the ureter. If the stone cannot be readily removed by means of the cystoscope, a cutting operation should be done. I have found that the operation is greatly facilitated by the use of the flexible curette shown in Figure 1. The value of this curette lies in the fact that it is very flexible and yet stiff enough to resist an ordinary pull, and that the cup-shaped lip has an over-hang directed toward the shaft of the instrument.

This curette can rather readily be pushed past the stone, which is caught in or against the lip as the curette is withdrawn (Fig. 3A). Thus by gentle traction the stone can be rolled out of its position toward the incision in the ureter (Fig. 3B and C). By gentle manipulations the curette can be passed through a rather small opening in the ureter or kidney pelvis; one is not so likely to break off a particle of the stone with the curette as with forceps; and the curette can be used "around the corner" in the kidney pelvis, thereby dislodging a stone in a calyx which would not be accessible to forceps (Fig. 3D and E). With the aid of this instrument I have been able to remove stones from the kidney pelvis and the calyces without lifting the kidney out of its bed, a very important consideration, as any unnecessary manipulation of the kidney necessarily must interfere with its proper functioning. Of course,

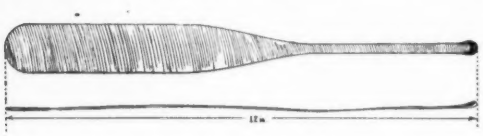


Fig. 1. Front and side views of flexible copper curette.

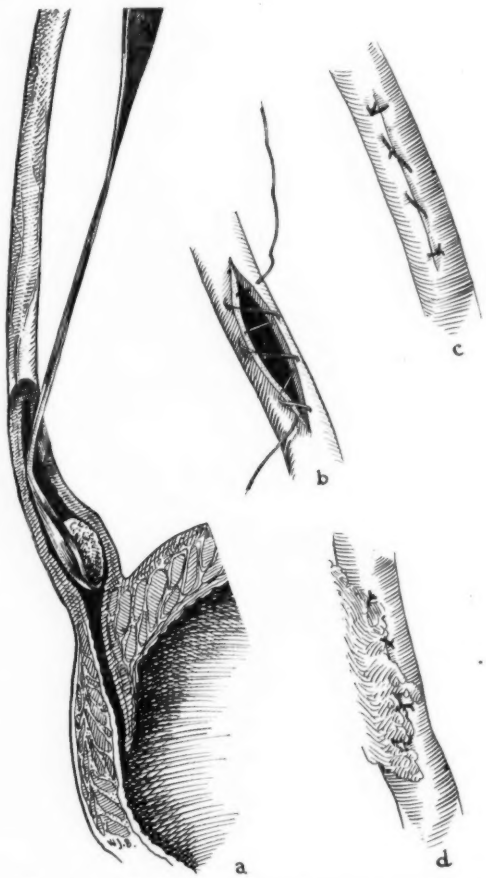


Fig. 2. A, Technique of removing stone from lower ureter near its opening into the bladder. B, Continuous suture through cut edges of ureter, the suture passing between serosa and mucosa. C, Incision after suture is in place. D, Fat-tabs from adjacent territory sutured over line of incision.

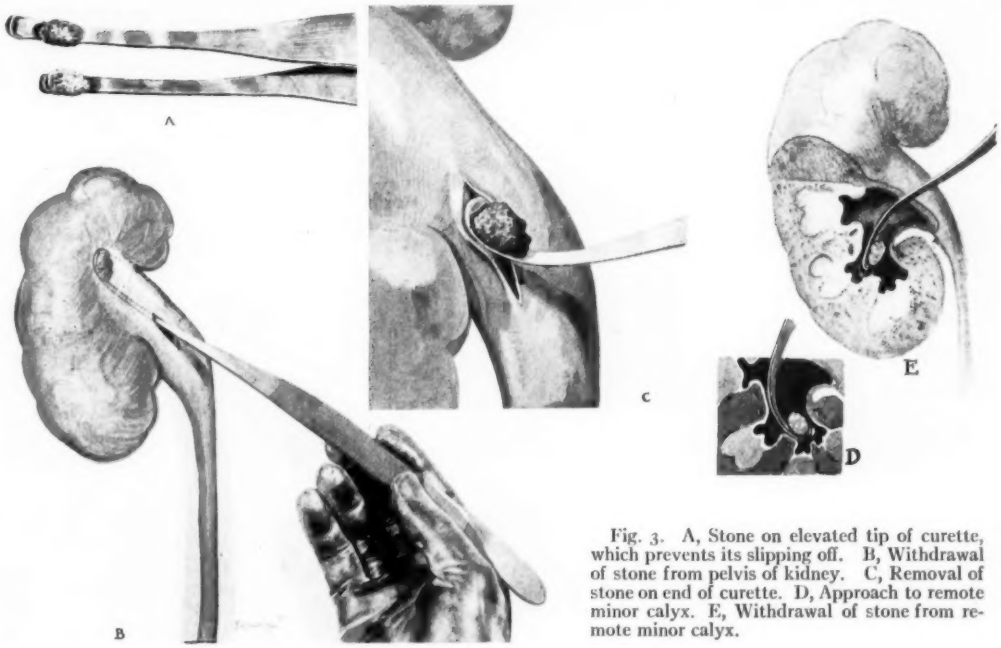


Fig. 3. A, Stone on elevated tip of curette, which prevents its slipping off. B, Withdrawal of stone from pelvis of kidney. C, Removal of stone on end of curette. D, Approach to remote minor calyx. E, Withdrawal of stone from remote minor calyx.

this instrument is not designed for the removal of a large forked stone such as sometimes fills the entire kidney pelvis and calyces, but rather for the smaller, loose stones.

In removing a stone from the ureter it may be desirable not to make the incision in the ureter directly over the stone, as, for instance, when the stone is lodged in the lower ureter, very near its opening into the bladder. In such a case it is well to make an incision above the point at which the stone is lodged; the curette is then passed through the incision and is carefully guided along the ureter until its lip has passed beyond the stone, which can then be dislodged by gentle manipulation and brought to the opening in the ureter (Fig. 2A). The incision is closed by a continuous suture which passes between the serosa and the mucosa of the cut edges (Fig. 2 B and C), and fat-tabs taken from the adjacent territory may be sutured over the line of incision (Fig. 2 C).

FROM THE CLINIC OF DR. TERRY, UNIVERSITY OF CALIFORNIA MEDICAL SCHOOL

THE TECHNIQUE OF GASTROJEJUNOSTOMY WITHOUT CLAMPS

By JOHN HOMER WOOLSEY, M.D., F.A.C.S., San Francisco, California

GASTROJEJUNOSTOMY, despite the many accusations made against it by those who know and those who do not, is still the one procedure that gives universally better results for duodenal, pyloric, and low gastric (antral) lesions. Pyloroplasty is preferred if possible and partial gastric resection has its indications but gastrojejunostomy is of necessity a more common procedure. The technique of gastrojejunostomy ordinarily embodies the use of compression clamps, although evidence is at hand that jejunal ulcers have occurred exactly where the clamp pressure was applied. In our endeavor to eliminate all possible causes for gastrojejunal and jejunal ulcer—one of the greatest objections to gastrojejunostomy—we are seeking atraumatic surgery. The compression clamps were developed originally to prevent leakage and contamination from the gastro-intestinal canal. Today with proper pre-operative preparations and proper operative technique, leakage does not occur. In addition it is recognized that the jejunal, duodenal and stomach content except in malignancies is relatively sterile. Therefore, since it is less traumatic as well as easier to perform, a technique without clamps is employed at this clinic for gastrojejunostomy.

INDICATIONS

Gastrojejunostomy is indicated: (1) where the degree of inflammatory reaction in the region of the pylorus is too severe to allow a pyloroplasty; (2) in the presence of a penetrating duodenal ulcer in the head of the pancreas with or without complications; (3) in the presence of duodenitis; (4) in benign gastric lesions at a distance from the pylorus; (5) in the first stage of a Billroth II resection; (6) when the patient's poor general condition demands a two-stage resection; and (7) as a palliative measure in cases of inoperable gastric malignancy with obstruction.

PRE-OPERATIVE PREPARATION

Pre-operative preparation is of maximum importance. The routine followed is based upon the combined personal clinical observations and study of our staff. In general, all patients are given a soapsuds enema the evening before and then allowed to sleep as late as possible in the morning. A light supper is given unless pyloric obstruction is present and water *ad libitum* is allowed up to the time of operation. In instances of pyloric obstruction with 50 per cent stasis, gastric lavage is employed 1 hour before operation while in instances of total or subtotal stasis, gastric lavage is given twice daily during the last pre-operative 24 or 48 hours. Hypodermoclysis of Ringer's solution and infusion of intravenous glucose are employed as indicated. Blood transfusion is also employed according to the usual recognized indications. The general idea in mind is to disturb the gastro-intestinal tract as little as possible, to give the patient maximum rest, to have the stomach clean, to keep the fluid intake normal—between 3,000 to 4,000 cubic centimeters daily—and to augment the blood when there is need.

Twice on the day preceding operation, if possible, and once just before going to the operating room the teeth are brushed with a mixture of equal parts of talc and soda bicarbonate, the mouth rinsed with an alkaline mouth wash and then the teeth and gums are painted with a 50 per cent alcohol solution containing 1 per cent each of brilliant green and crystal violet (Berwick's dye). As a result of this treatment there has been a notable decrease in the postoperative respiratory complications.

ANÆSTHESIA

A preliminary hypodermic of morphine sulphate .015 and scopolamine .0003 is given to all adults one-half hour before operation. Nitrous oxide and oxygen anæsthesia alone is used and is satisfactory unless too much manipulation and exposure of viscera is performed. Ether in combination with the above gases is then added and frequently is so employed for the closure of the abdominal wound.

TECHNIQUE OF GASTROJEJUNOSTOMY

The location upon the stomach for the site of the gastrojejunostomy is chosen as the most dependent portion close to the greater curvature or just opposite to the excised ulcer of the lesser curvature. The transverse colon is now lifted sufficiently to make the mesocolon taut and an opening is made through the latter by knife blade

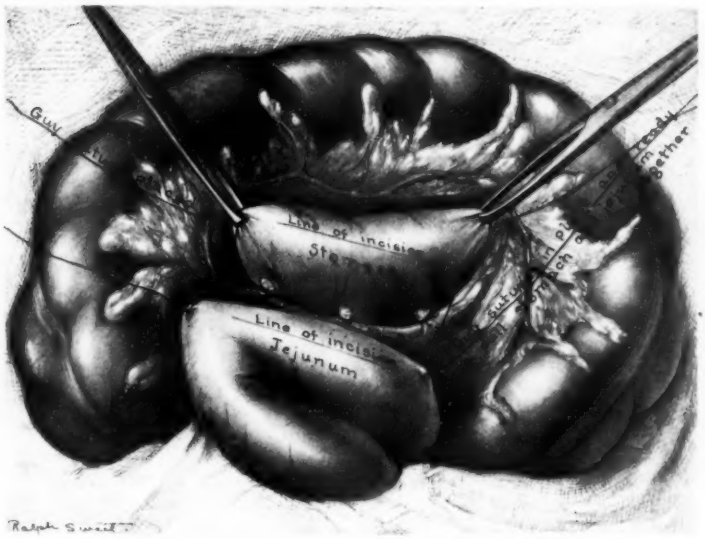


Fig. 1. Method of attaching mesocolon to stomach and guy sutures in place.

dissection. The chosen portion of gastric wall is pushed through and a form of holding clamps, light weight Allis, is now gently applied to the gastric wall and held by the assistant. The mesocolon is attached to the portion of the stomach that will eventually lie posterior to the gastrojejunostomy, by suturing with fine catgut into the stomach wall and tying over a small portion of the mesocolon (see Fig. 1). The jejunum which had previously been located is placed alongside the stomach. The portion of jejunum 7.5 centimeters (3 inches) from its emergence through the base of the mesocolon is usually the desired point for anastomosis.

Guy sutures of gastro-intestinal suture No. 1 are now taken through the stomach and jejunum at either end of the site for anastomosis and a Kelly hæmostatic forcep applied to the ends of each respective guy suture. The Allis forceps are removed and the assistant holds the guy sutures up and out so as to give proper exposure. A small portion of gauze packing or a Mikulicz abdominal tape is then placed behind the proposed line of anastomosis.

The outer or posterior layer of suture is begun at one end and after tying two knots a clamp chosen uniformly so as to serve as a definite marker applied to the short end. A continuous Lembert suture with occasional locked stitch and two locked stitches at the end is applied.

Incisions through the gastric serosa, muscularis, and submucosa are made. These incisions are effected with the point of the knife so as to expose but not sever the prominent blood vessels. These blood vessels are then ligated on each side with black silk B on milliners' needles. A non-absorbable suture is used here and is so used

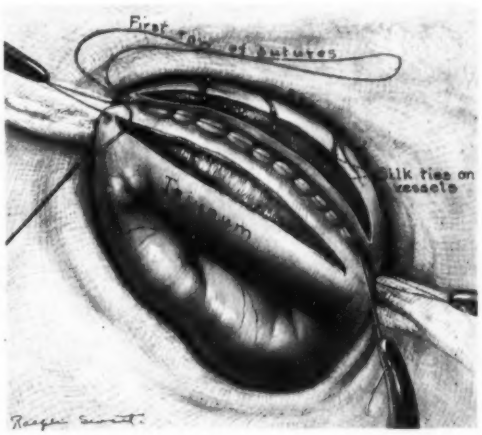


Fig. 2. Outer posterior continuous suture placed with its short end marked by a special hæmostat. Ligation of the main transectable blood vessels of the stomach with black silk B.

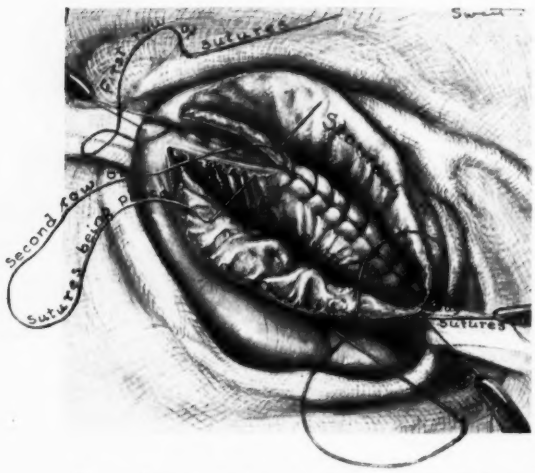


Fig. 3. Inner posterior continuous suture beginning at center and placed in locked manner.

because of its size, flexibility, and the fact that it will eventually be turned completely into the lumen and soon sloughed. The blood vessels are cut and the mucosa opened. Should bile tend to leak from the jejunum, a gauze strip of packing may temporarily be employed. The stomach as a rule never leaks because the holding of the guy sutures up and out causes the cut sides of the stomach to approximate in a valve-like action. The protruding mucosa is rarely amputated but on the contrary is adjusted to its normal place with each suture. If desired, one may explore the stomach digitally from within before further closure is effected.

The inner layer of suture is begun at the middle of the posterior side. A gastro-intestinal suture with a needle at each end is preferred. A locked stitch across the entire posterior wall is employed as it gives added assurance of hæmostasis and leaves the mucosa in a smoother and more uniformly apposed manner. As each end of the anastomosis is reached, the type of suture is changed to a continuous Connell with an occasional locking on the inside of the lumen. This suture is ended at the center of the anterior wall and the knot invaginated.

The original outer or posterior suture layer is now continued in the form of a continuous Lembert stitch occasionally locked and finally tied with the end upon which the marker clamp had been placed. The guy sutures are next tied but before being cut are employed to hold out the stomach so that the mesocolon can be attached anteriorly to the stomach wall in the manner previously described. The guy sutures are utilized therefore as additional support to the weakest spots of the gastrojejunostomy.

During this operation as in all major surgical work the patient is simultaneously being given a hypodermoclysis of Ringer's solution in the mesial side of the thighs. An average of 1,000 cubic centimeters and as much as 2,000 cubic centimeters is at times so administered to the patient.

POSTOPERATIVE CARE

The patient is allowed postoperatively to assume the position of comfort unless there is some indication otherwise. He is allowed either hot or cold water in teaspoonful amounts as soon as he is awake. He may hold ice in his mouth. The following day, 18 to 24 hours postoperatively, he is allowed plain water, alkaline waters, orange juice, and weak tea in small amounts, gradually increasing the amount until on the second day postoperatively he is taking at a time any quantity desired. On the third day he is allowed soft palatable food as well as cooked gruels, soft boiled or poached eggs, toast, custards, baked or mashed potato, purees, gelatine dishes, etc.

Emphasis is placed upon the fluid intake and output. This is accurately kept and charted. A total of 3,000 cubic centimeters per 24 hours for the average adult is the desideratum. Ringer's and normal salt are employed subcutaneously and glucose 10 per cent or 5 per cent intravenously.

Should the patient have continued emesis, then interrupted or continuous gastric lavage is main-

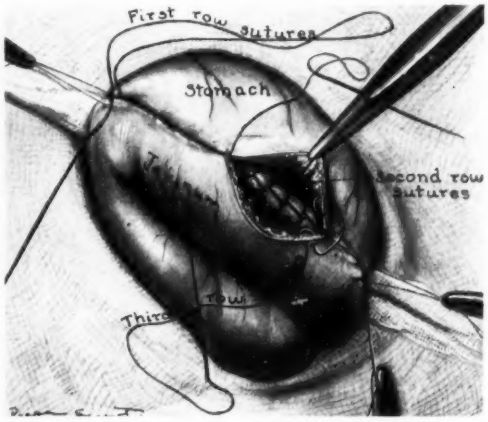


Fig. 4. Inner anterior continuous suture applied according to Connell, a continuous mattress type and ended at the center anteriorly.

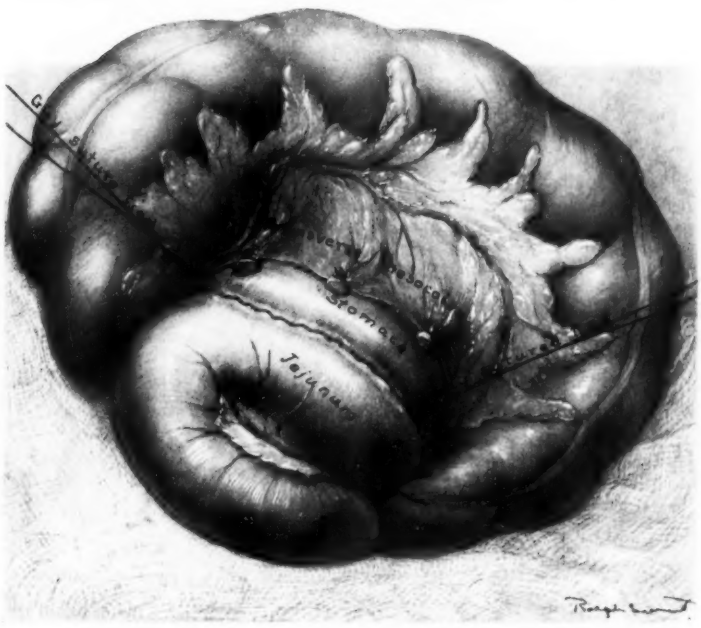


Fig. 5. Completion of the outer anterior suture. Tying of the guy sutures. Attachment anteriorly of the mesocolon to the stomach wall.

tained by use of the Jutte tube and Connell suction pump. This tube is passed via the nostril and may be left in place for 4 to 5 days without any great discomfort to the patient.

For postoperative distention, the rectal tube, change of position and hot abdominal stupes with protection to the wound dressing is the routine. Enemata are avoided especially if any likelihood of peritonitis exists. Morphine to give the patient rest is preferred. The bowels, as a rule, move without stimulation on the fifth to sixth day. Liquid petrolatum one tablespoonful twice daily thereafter until the patient is up and about is the usual treatment.

The patient is allowed to be up on the twelfth day and to leave the hospital on the fifteenth day. He returns to his usual vocation unless contraindicated on or about the sixth week postoperatively. His postoperative care as regards diet is followed for approximately 6 months. All patients are examined with the X-ray and test meal approximately 5 weeks after operation.

CONCLUSION

After the employment of this technique for a period of two and one-half years in all forms of gastro-enterostomy, we are convinced of the decreased trauma and the increased ease over that technique where compression clamps are used. The postoperative results are excellent both as to function, which is in part dependent upon judgment as to the type of surgical treatment needed, and to the lack of any sequelæ such as gastrojejunal or jejunal ulcers.

A NEW UPPER ABDOMINAL INCISION

By G. A. SLOAN, M.D., Bloomington, Illinois
The Sloan Clinic

IN the earlier days of abdominal surgery, if the prime end of life saving was attained, little attention was paid to the abdominal incision. Incisions were made at various angles and in various directions, depending in most part upon the operator's idea of the best manner in which to approach the objective field through the shortest and most direct incision.

With asepsis came the fashion of the longer incision, and closer and keener attention was paid to the ways of making and closing the wound. Operators became more daring, and easy access to the parts to be attacked became the chief consideration. The longitudinal incision was adopted by many abdominal operators and gained almost universal popularity. Careful and skillful closure of the long incision was thought to secure against the remote as well as the immediate unfortunate results of abdominal surgery. The importance of gaining free access to the underlying structures outweighed all considerations as to ventral weakening. Close and accurate suturing of the peritoneum was supposed to prevent as much as possible the formation of postoperative adhesions underneath the old incision. But it was taken for granted that in the majority of cases adhesions would form underneath the scar.

PROBABILITY OF POSTOPERATIVE HERNIA

Prolonged observation however showed that any transverse division of muscular or fascia fibers leaves a permanent and irremediable weakness at the site of division; that close suturing may be followed by firm union for months or even years, but that in time at least some stretching of the cicatrix will certainly take place. Transversely severed fascial or muscular fibers cannot be united in any way that leaves a permanent closure as strongly united as before operation. Gradual weakening of the scar will inevitably occur. Almost as many postoperative hernias become evident during the tenth year following incision as during the second year.

INCIDENCE OF POSTOPERATIVE HERNIA

According to Southam (9), out of 29,000 abdominal operations, 596, 2 per cent, were performed for the repair of postoperative abdominal hernia. According to Boeckmann (1), Abel's statistics from German clinics had shown 8.9 per cent hernias after longitudinal incisions with healing *per primam* and 31 per cent after healing *per secundam*.

DIFFICULTIES IN CLOSURE OF LONGITUDINAL INCISIONS

Quoting Quain (8): "All those who have made a number of gall-bladder operations through longitudinal incisions in tense abdominal walls will remember instances in which it seemed impossible to make a satisfactory serosa-to-serosa closure of the peritoneum because of the lateral pull on the so-called posterior sheath of the rectus muscle. Sometimes the suture would cut through the peritoneal margin again and again until there was no hope of making a smooth closure of the frayed-up edges. Finally, a few stitches were probably placed far out into the rectus muscle in a desperate but vain effort to overcome the difficulty and to leave no raw surface facing the viscera.

"In the hands of many operators this manner of opening the abdomen is chosen solely because of its fancied convenience to the operator, and without due consideration of the fact that in every longitudinal transrectal or pararectal incision irreparable damage may be inflicted on the patient."

RELATION OF LENGTH OF INCISION TO INCIDENCE OF HERNIA

The old rule that the danger of hernia with longitudinal incisions increases in proportion to the square of the length of the incision seems to be borne out in our experience. Thus in a given number of operations if there were nine hernias with 3 inch incisions, there would be 16 with 4 inch incisions and 25 with 5 inch incisions. Over 80 per cent of the patients that we have seen with 10-year-old 5 inch scars from upper abdominal incisions have had some appreciable and demonstrable weakening of the abdominal wall at the site of the old scar; over 60 per cent of those with scars 4 inches long and 10 years old have had appreciable weakening of the abdominal wall at the site of the old incision; 27 per cent of those who have 3 inch 10-year-old scars have had definite evidence of weakening of the scar; while less than 5 per cent of those who have had incisions shorter than 3 inches have such evidence.

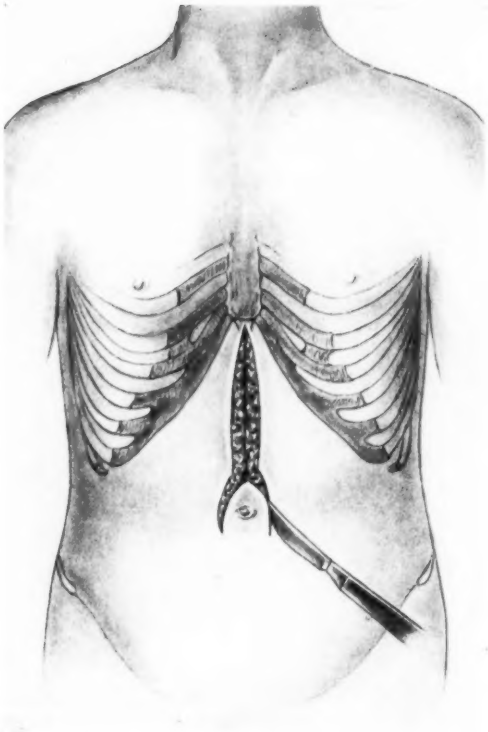


Fig. 1. An incision through the skin and fat down to the fascia from the ensiform to a point 3 centimeters above the umbilicus and continued outward and downward on each side of the umbilicus to a point 4 centimeters below the umbilicus on either side, leaving a V-shaped piece of skin and fat around the umbilicus.

With the longitudinal incision, the transverse fascia fibers are severed and must be coapted in such a way as to remain in close apposition for from 10 days to 2 weeks for union to occur.

The tensile strength of aponeurosis like that of the transverse aponeurosis of the abdomen is enormous. Every time that the intra-abdominal tension is increased by coughing, vomiting, or straining, the tension thrown directly upon the stitches or sutures holding the ends of severed transverse aponeurotic fibers together is enormous.

McArthur (4) has called attention to the fact that the transversalis muscle is a muscle of respiration and its median attachment is subjected to strain with each respiration. Following a longitudinal incision this strain obviously must be borne by the sutures.

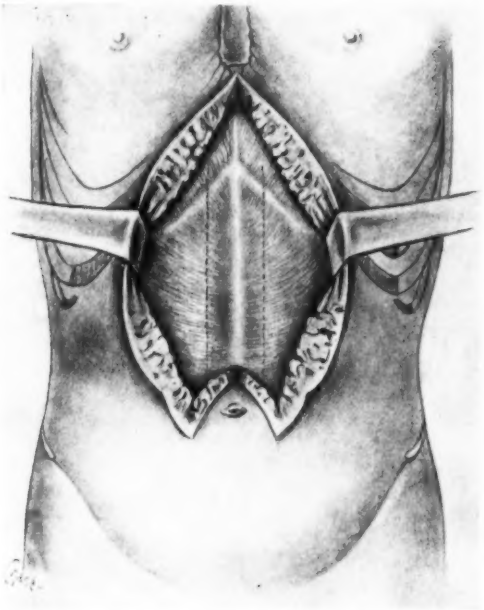


Fig. 2. Dissection outward of flaps of skin and fat exposes the aponeurosis over the inner borders of the rectus muscles.

METHOD OF MEASURING THE RELATIVE VERTICAL AND LATERAL TENSION

By measuring the tension with spring scales attached to several forceps, the force required to bring the ends of the severed transverse fibers together following a longitudinal incision while the patient is lightly anæsthetized can be estimated. By the same procedure, with a transverse incision in which the rectus muscles have been cut transversely, one can arrive at a somewhat accurate estimation of the amount of force required to bring the layers of the abdomen together vertically.

In the same way with an L-shaped incision, one side of which is longitudinal and one transverse, the lateral and vertical force required for closure can be accurately measured.

Rule for estimation of the tension upon the suture line following a longitudinal incision. The longer the longitudinal incision the more force is required to bring the ends of the fibers of the divided aponeuroses together. *The force required increases in proportion to the square of the length of the incision.* Thus, in a 3 inch longitudinal incision, immediately after the incision is

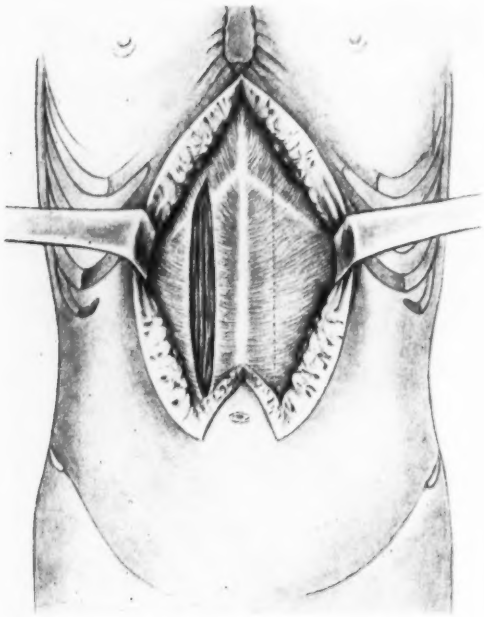


Fig. 3. Vertical incisions are made through the external sheaths of the recti about 1 centimeter external to their inner borders. Upon the length of those two incisions will depend the amount of exposure that it has been possible to obtain.

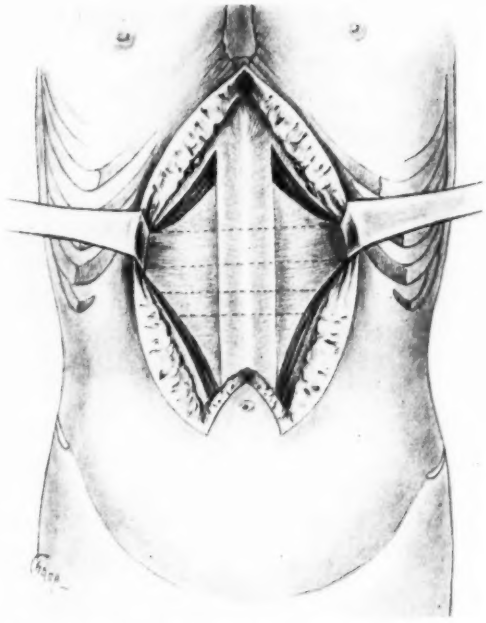


Fig. 4. The rectus muscles with the overlying external sheath, fat, and skin are rolled outward and held by suitable retractors, exposing the posterior sheath of the recti. Dotted lines indicate locations that may be chosen for the transverse incision through aponeuroses and peritoneum.

made and before the oblique muscles have retracted the aponeuroses, perhaps about 30 pounds of pull will bring the aponeuroses together during light anæsthesia; while in a 4 inch incision it will require nearly 50 pounds to bring the ends of all the aponeuroses together. If the incision is lengthened to 5 inches it will require about 80 pounds with the patient in the same degree of anæsthesia. Therefore, we seem justified in formulating the following rule: The lateral pull upon the suture line following a longitudinal abdominal incision is in proportion to the square of the length of the incision.

Estimated relative amount of tension upon the suture line with longitudinal and transverse incisions. So far as we have been able to determine, when complete relaxation is not present, the lateral abdominal tension is about thirty times as great as the vertical. If this is correct, the strain upon the suture line of a longitudinal incision is *thirty times* as great as that upon the suture line of the transverse incision.

Not only that but as has been pointed out by Farr (2), the distance between the pubis and the ensiform can be shortened by suitable posture, and the "relaxed abdominal wall relieved of *all* vertical tension." Should the sutures hold throughout the entire length of the longitudinal incision and the severed ends of the transverse fascia fibers be held in apposition until healing is complete, the risk of hernia is lessened, especially the immediate risk. But it goes without saying that the thin strip of scar tissue is quite inadequate to bear up under the original strain. This thin scar is under tension every hour of every day as long as the patient lives. It is well known that scar tissue under strain will gradually lengthen and weaken. Therefore, *some* weakness will invariably follow.

MUSCLE SPLITTING INCISION IN THE LOWER ABDOMEN

It has long been recognized that the danger of hernia, especially the remote danger, is of enough actual importance to the patient to make it of prime importance that some method be devised by which this danger can be eliminated. It has been evident to many surgeons of large experience

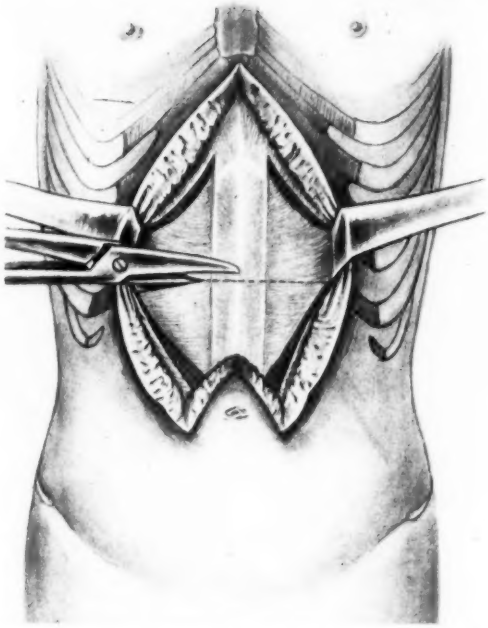


Fig. 5. After the retractors are in place and the sheath of the rectus exposed a transverse incision is made through the exposed posterior reflexion of the sheath of the rectus and the peritoneum.

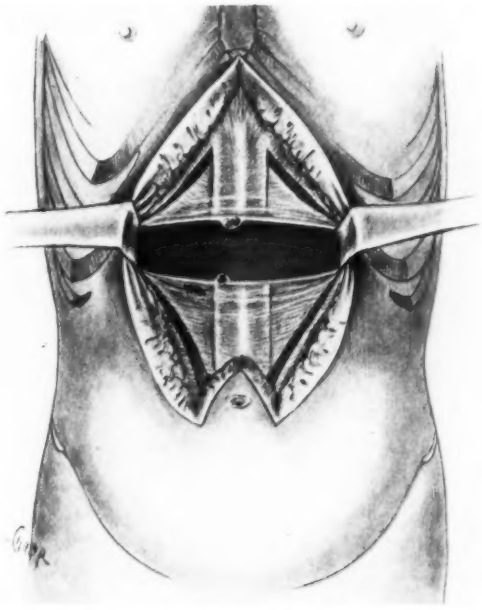


Fig. 6. The incision is extended across the linea alba parallel to the direction of the fibers of the aponeuroses from the outer edge of one rectus muscle to the outer edge of the other.

that this can be done only by making the lines of incision through the different structures *parallel* with the direction of the most important fibers. This result has been accomplished in the lower abdomen by the development of the Pfannenstiel incision.

Kustner (3), a German gynecologist, in 1896 recommended a transverse incision in the lower abdomen. In the same year, Rapin, a Swiss gynecologist, reported the use of the same incision and recommended it most highly.

The Pfannenstiel incision in the lower abdomen. Pfannenstiel (6) in 1900 presented in quite an elaborate manner the advantages of the combined transverse and longitudinal incision in the lower abdomen. In the same year, Stimson, of New York, and Hartmann, a French surgeon, independently began using the same incision. In 1907, Pfannenstiel reported a total of 700 pelvic operations through his incision. Pfannenstiel claims a 4 per cent reduction in mortality, with a larger percentage of healing by first intention than with the longitudinal incision, and elimination of the danger of hernia.

Kroenig and Menge, in 1903, published reports commending it from the same standpoint. Stimson (11) in 1904 reported 150 operations with this incision. Wanscher, a Danish gynecologist and Henricius and Engström, Finnish gynecologists, reported favorable results from this incision in 1909.

Proved advantages. Many men in the United States were active in recommending the Pfannenstiel incision in the lower abdomen during the period from 1905 to 1909; Walker, of Detroit, being one. In the same year, 1909, Eduard Boeckmann (1), of St. Paul, published quite a complete review of the literature extant along with his results in four hundred operations. All testified to its great advantages in the prevention of hernia, and several surgeons reported reduction of the incidence of postoperative abdominal adhesions by its use.

The Pfannenstiel incision modified to meet our needs has been used routinely in our clinic for all pelvic operations since 1909. We are convinced that from the standpoint of the patient's welfare it is far superior to the longitudinal one. The

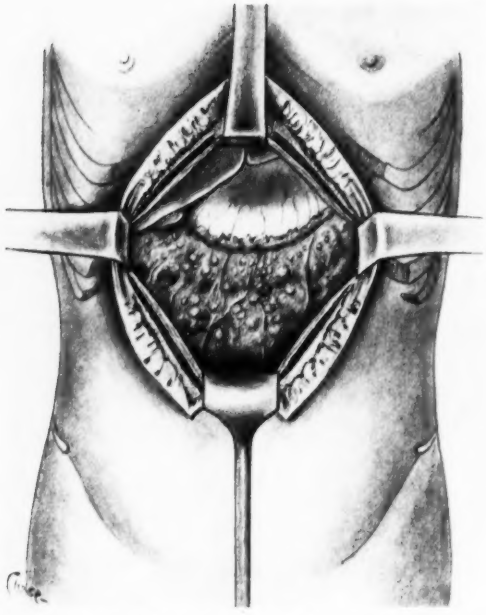


Fig. 7. Retraction upward and downward affords an opening with a diameter about equal to the length of the incisions in the anterior sheaths of the rectus muscles.

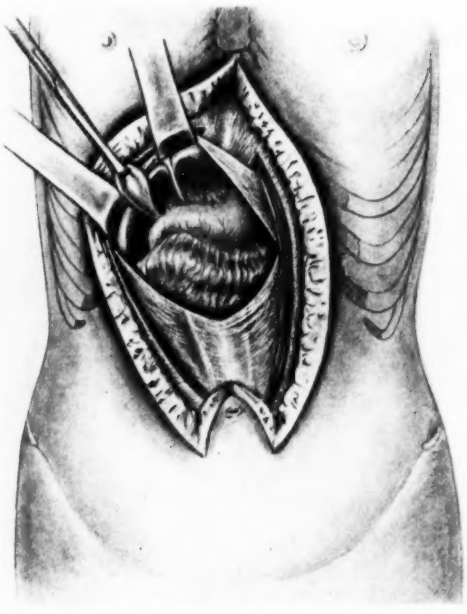


Fig. 8. Retraction upward and outward affords access to the gall bladder region. The opening can be retracted over the regions of the spleen or appendix also.

dangers of postoperative hernia and separation of the wound margins are eliminated. The convalescence is shortened and postoperative discomfort is markedly lessened.

Sprengel's transverse upper abdominal incision. In 1910, Sprengel (10) published a description of a transverse incision in the upper abdomen and reported its use in a number of cases with excellent results. Moschcowitz (5), of New York, Farr (2), of Minneapolis, and many other writers have reported results with the transverse incision in the upper abdomen, and testified to some of its undeniable advantages over the longitudinal one. It affords ample room for access to all organs in the upper abdomen. It is easily closed and according to some surgeons followed by almost no danger of postoperative hernia. The nerve supply of the abdominal wall is not interfered with. Its lack of popularity may be due to the fact that most of us have a prejudice against severing such large muscles as the recti.

McArthur's incision. In 1915, McArthur (4) published a description of his combined vertical and transverse incision for operation upon the gall bladder. The usual paramedian incision is made through the right rectus muscle and the fibers of the aponeurosis of the transversalis are separated transversely. He emphasizes the fact that "the transversalis is an active respiratory muscle and following a longitudinal incision, with each respiration it so tugs and pulls on the line of sutures as to make it give away." By separating the fibers of the aponeurosis of the transversalis instead of cutting them, this cannot occur. With this incision there is danger of destroying the nerve supply to the median portion of the rectus muscle and adequate exposure for approach to the stomach, appendix, or spleen is not afforded.

POSTOPERATIVE ADHESIONS

A consideration, however, of greater importance than that of ventral or postoperative hernia is that of postoperative adhesions to the under surface of the scar. Moschcowitz (5) in discussing the closure of the longitudinal wound from the standpoint of postoperative intra-abdominal adhesions says:

"Very frequently, however, almost unsurmountable difficulties arose, especially in the application of the first suture line. In most of our operations, particularly if the patient is very obese or very muscular, the suture of the peri-

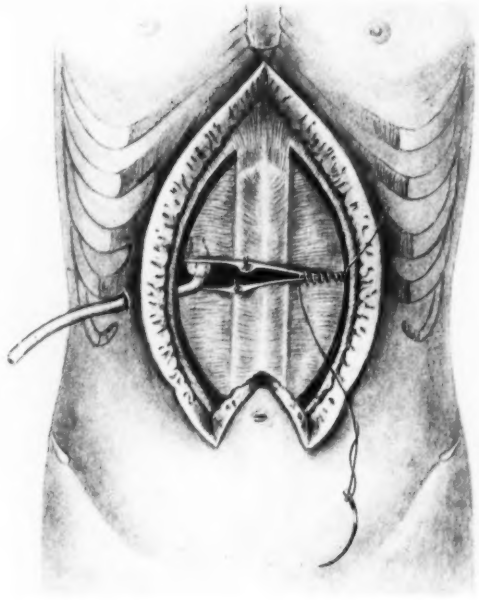


Fig. 9. In cholecystotomy the drainage tube is brought out through a puncture wound and the gall bladder is brought to the abdominal wall at any point desired.

Fig. 10. The appendix is more readily dealt with through this incision than through a high right rectus incision of any reasonable length.

toneum is extremely difficult. The stitches tend to cut through; to overcome this tendency, one is inclined to include more tissue in the bite of the needle; unfortunately, this procedure not only does not mitigate the difficulty, but actually increases it.

"After a great deal of trouble, and with considerable loss of temper, the surgeon finally succeeds in finishing the suture line; the result, however, is not satisfactory; the suture line is weak, and there are generally present also a number of smaller or larger holes, which permit the prolapse of small bits of omentum. In the greatest majority of the cases this suture line is so precarious that its protective value is nil. It is, of course, possible that it acts as a prophylactic to the formation of adhesions, by preventing contact between the intraperitoneal viscera and the extraperitoneal tissues. But even this is, I believe, illusory; as in the secondary operations that have fallen to my lot, I have found the adhesions to be so massive as to lead me to suspect that the suture line gave way upon the first strain, and not only permitted, but actually invited the contact which it was presumed to prevent. In this connection it is of great interest to know that Sprengel found at autopsy, in a few cases which died shortly after a laparotomy through a vertical incision, that the peritoneal suture line had completely separated.

"In a very large number of cases even this flimsy closure was impossible, and after vainly trying to fortify the first suture line by including a part of the rectus, the attempt at a layer suture was very frequently given up in disgust, and the wound had to be closed practically *en masse*, the first suture line including the entire thickness of the abdominal walls, with the exception of the skin. I have often said on such occasions that by far the most difficult part of my operation upon the gall bladder or biliary passages is the closure of the abdominal incision."

Adhesions from destruction of nerve supply. Quain (7) in a very exhaustive report of the results of an experimental study says: "An analysis of the results of the fifteen experiments in which trauma, or trauma plus irritation or infections, was applied on the parietal peritoneum shows that in eight the adhesions (seven omental and one hepatic) were confined to the side of nerve extirpation; two of the three cases having adhesions on both sides of the linea alba had more extensive

Fig. 11. The closure of the peritoneum and posterior layer of aponeurosis is begun at the outer ends of the transverse incision.

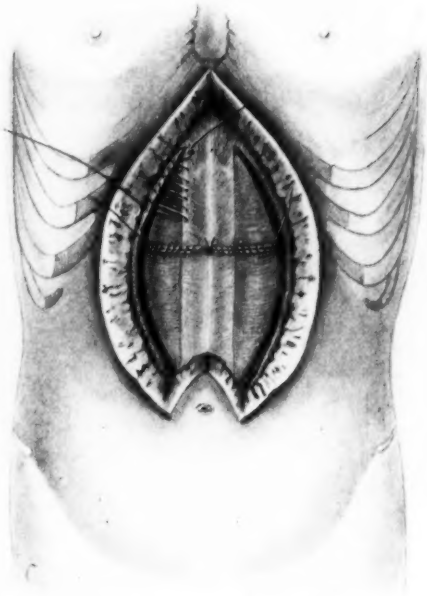


Fig. 12. No difficulty is experienced in closing the abdomen even with the largest and fleshiest patient as no tension whatever is required to bring the edges together.

adhesions on the side operated upon than on the normal side; one case had fibrin deposits, which were limited to the enervated side; and one rabbit having no adhesions had a marked infiltration of the peritoneum on the side operated upon, thus leaving only three animals in which no material difference between the two sides was noted."

He also says: "From time to time I have had occasion to operate on patients who had previously been operated on through lateral abdominal incisions placed in such a way as to sever intercostal nerves. The findings in such cases have suggested a possibility that the omentum may have a greater tendency to adhere permanently to that part of the abdominal wall which has been deprived of intercostal nerve supply than to any other part of the parietal peritoneum.

"If a peritoneal surface deprived of its intercostal nerve supply be subjected to a trauma, or to a trauma plus infection or irritation, such as may obtain during an operation, more adhesions and a more chronic infiltration of the peritoneum are likely to follow than if the same injuries were inflicted on a peritoneum with normal nerve supply."

Several other observers have published evidence of the high incidence of adhesions found under the median portion of the rectus muscle after its nerve supply has been destroyed by a longitudinal incision.

Incidence of postoperative adhesions. We make it a practice when we open the abdomen of a patient who has had a previous operation to explore by palpation under the old scar. We have never yet found more than slight adhesions to the scar when cholecystotomy had been done through a very short or stab wound. On the other hand, we have never yet explored the upper abdomen under a scar from an incision 3 inches or more in length in which dense adhesions to the under surface of the scar were not found. We cannot see how it could be otherwise. For at least 10 days subsequent to operation the lateral tension upon the line of sutures must necessarily produce irritation that will be followed by an inflammatory reaction not only in the aponeurosis but in the underlying peritoneum. In all cases it has been noted that the omentum always becomes adherent to peritoneum which is inflamed.

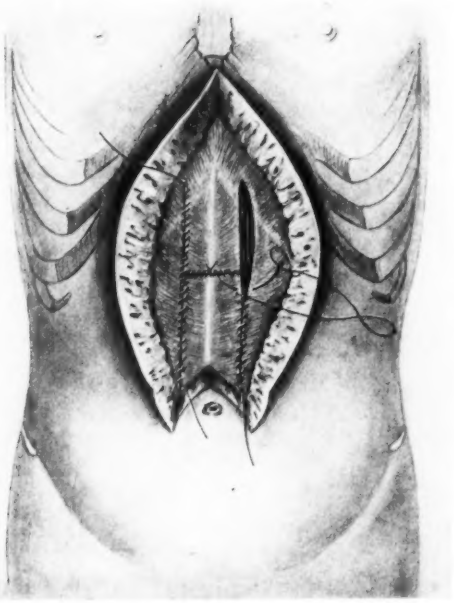


Fig. 13. No appreciable tension upon the sutures required to close the anterior sheath.

Requisites for prevention of adhesions. For the prevention of postoperative adhesions, it is of prime importance that an abdominal incision be used that does not destroy the nerve supply of any portion of the peritoneum, and that can be closed without tension upon the sutures in contact with, or through, the peritoneum. This obviously cannot be done unless the fascia fibers remain intact. The transverse incision meets this requirement and also gives ample exposure. I am convinced that greater accessibility may be obtained through the transverse incision than through the vertical incision, and with certainly less postoperative discomfort, because the line of incision may be entirely relieved of tension by proper posture.

OBJECTIONS TO CUTTING THE RECTI

Some few instances of hernia following the transverse incision have been reported. More instances of atrophy or thinning out of the recti adjacent to the incision have been observed. While the preponderance of evidence seems to prove the superiority of the transverse over the longitudinal incision, yet many of us have the opinion that the recti muscles are quite important structures of the abdominal wall, and that it is well worth while to preserve them, especially if their nerve and blood supply can be preserved intact.

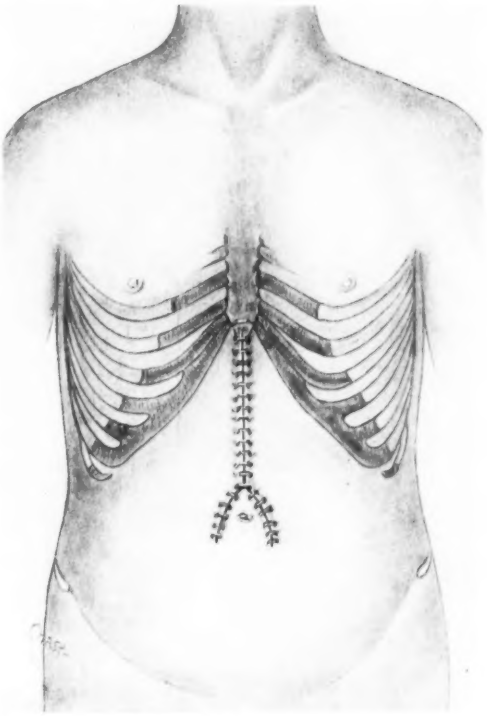


Fig. 14. The skin and fat flaps fall together with surprising readiness. In fact, skin clips are all that are required to hold the flaps of skin and fat together, and the scar is a fine line much superior to that of the usual incisions.

For years abdominal surgeons have sought for a method of approach to the regions of the upper abdomen that will provide adequate exposure without greatly weakening the structures of the abdominal wall.

A NEW UPPER ABDOMINAL INCISION

I wish to describe an incision that has been developed by members of our clinic that seems to meet the requirements mentioned. In the last 18 months we have used it one hundred and fourteen times. This incision preserves the recti and the fibers of their posterior sheaths. It does not interfere in any way with the nerve or blood supply of muscles, aponeuroses, or peritoneum. It preserves the posterior sheath of the rectus as well as all the transverse fibers in the region between

the recti. It is easily made and gives ample exposure for all operations in the upper abdominal region, such as operations upon the stomach, spleen, liver, gall bladder, colon, etc. It permits approach to the appendix and affords opportunity for exploration of the entire abdomen. If it is found necessary to operate upon the pelvic organs, they can be approached through a Pfannenstiel incision in the lower abdomen.

Description of the incision. An incision is made through the skin and subcutaneous tissue down to the aponeurosis extending from the ensiform to a point 3.5 centimeters above the umbilicus. It is continued outward and downward on either side of the umbilicus to a point on either side about 4 centimeters below the umbilicus, leaving a V-shaped piece of skin and subcutaneous tissue around the umbilicus. A flap of skin and fat dissected outward exposes the aponeurosis over the inner borders of both rectus muscles. Then vertical incisions are made through the external sheath of the recti about 1 centimeter lateral to their inner borders. Upon the length of these two incisions *will depend the amount of exposure* that is obtained.

The recti with the overlying external sheath, fat, and skin are rolled outward and held by suitable retractors. A transverse incision is made through the exposed posterior sheath of the rectus and the peritoneum and extended across the linea alba parallel to the direction of the fibers from the *outer* edge of one rectus muscle to the *outer* edge of the other. Lateral and vertical retraction affords an opening with a diameter about equal to the length of the incisions in the anterior sheaths of the recti. The only blood vessels encountered are some small ones in the fat and one or two in the falsiform ligament near the linea alba. With care, no bleeding from blood vessels in the recti occurs. No important nerves are cut. This gives ample approach for all operations in the upper abdomen. The opening can be retracted over the regions of the gall bladder, spleen, or appendix.

For operations on the gall bladder. Retraction upward and outward affords access to the region of the gall bladder, liver, and hepatic flexure of the colon. For cholecystectomy or cholecystotomy, the right half of this incision is all that is usually required. An evident advantage is the ease with which one-half of this incision can be converted into the larger one. When cholecystotomy is performed, the drainage tube is brought out through a puncture wound and the gall bladder is brought to the abdominal wall at any point desired.

For appendectomy. Retraction downward and outward affords access to the region of the appendix. The appendix is more readily dealt with through this incision than through a high right rectus incision unless it be of unreasonable length.

Closure: Posterior sheath and peritoneum. The closure of this incision is quite simple as the transverse fibers have not been severed. If the closure of the peritoneum and posterior sheaths of the recti is begun at the outer ends of the transverse incision, no difficulty is experienced even with the largest and fleshiest patient, as no tension whatever is required to bring the edges together.

Closure of anterior sheath. Even with the longitudinal incision there is rarely any difficulty in coapting the edges of the anterior sheath of the rectus muscle if the posterior sheath has been well brought together. In fact when the posterior layer has been brought together, the abdomen is closed and tension is taken off of all other structures; with this incision the posterior sheath falls together and has its original strength. The rectus muscle is firmly attached to its anterior sheath, but not to the posterior. During straining, vomiting or coughing, contraction of the rectus pulls the flap of the anterior sheath inward and relieves the suture line of strain. Therefore, there is no appreciable tension upon the sutures placed in the anterior sheath. The skin and fat flaps fall together with surprising readiness. In fact, skin clips are all that are required to hold the flaps of skin and fat together, and the scar is a fine line much superior to that of the usual incisions.

It may require a very little more time to open the abdomen by this route. However, much time is saved in the closure and much difficulty is avoided. All authorities agree that even with deep anæsthesia and complete relaxation difficulties are sometimes encountered in the proper closure of the posterior fascial layer with a longitudinal incision. With this incision the lateral pull on the sutures is entirely avoided, and such complete relaxation is not necessary.

The presence of sepsis. This incision is of great advantage when an infectious process requiring drainage is present. In 72 of our 114 cases operated upon by this method, 7 of which were septic cases, drainage was instituted through the transverse incision of the posterior sheath and brought out through the rectus muscle, anterior sheath, and skin by a stab wound. Three septic cases were drained through stab wounds placed above the incision. In 4 cases of perforation from ulcer of the stomach, the drainage was brought out at

the inner edge of the rectus through this incision. In one case of multiple abscesses in the liver, drainage continued for 7 weeks; yet at this time, 2 to 18 months after operation, only one patient of the series shows any evidence of hernia.

CONCLUSIONS

The apparent advantages of this incision are:

Almost complete absence of tension on the sutures of the posterior fascia layers reduces the probability of postoperative adhesions to the abdominal scar. The danger of wound separation and hernia is almost entirely eliminated.

Ample exposure is afforded for all operations in the upper abdomen.

Four-fifths of the postoperative discomforts following longitudinal incisions are prevented.

Closure is accomplished with great ease. Gas anæsthesia is sufficient; deep anæsthesia is not required. Convalescence is shortened, and a better scar is secured.

REFERENCES

1. Boeckmann. Transverse abdominal incisions. St. Paul M. J., 1910, June.
2. Farr. Abdominal incisions. J.-Lancet, 1912, Nov. 1.
3. Kustner. D. supras. Kreuzschnitt, eine Meth. d. Celiotomie, etc. Monatschr. f. Geburtsh. u. Gynaek., 1896, iv, p. 197.
4. McArthur. A modified incision for approaching the gall bladder. Surg., Gynec. & Obst., 1915, xx, 83.
5. Moschcowitz. Transverse incisions in the upper abdomen. Ann. Surg., lxiv, 268.
6. Pfannenstiel. Ueber die Vorth. des Suprasymph. Fascienquerschn., etc. Sammlung. klin. Vortr. Gyn., 1900, No. 97, 268.
7. Quain. Tr. West. Surg. Ass., 1913, 353-369.
8. Idem. The transverse incision in the upper abdomen. J.-Lancet, 1917, xxxvii, 657.
9. Southam. A comparative study of abdominal incisions. Brit. M. J., 1924, March 22, 613.
10. Sprengel. Kritische Betrachtungen ueber Bauchdeckennaht und Bauchschnitt. Verhandl. d. deutsch. Gesellsch. f. Chir., xxix, 95; and Arch. f. klin. Chir., xcii, 537.
11. Stimson, Lewis A. The combined transverse and longitudinal incision in laparotomy. Ann. Surg., 1904, No. 140, 178.

AVULSION OF THE DIAPHRAGM[1]

By W. A. BRYAN, M.D., F.A.C.S., Nashville, Tennessee

A LIMITED search has failed to reveal in the literature a case similar to the one under discussion. Rupture of the diaphragm and congenital defects resulting in herniation are numerous enough. So far as investigation has gone, they seem due to rupture through the body of the diaphragm or to the escape of abdominal viscera through the normally weak points. The case in hand, while allowing escape of abdominal contents into the pleural cavity, was purely an avulsion. Numerous articles and case reports are to be found dealing with the so-called eventration of the diaphragm, which also has no semblance to this case.

Mr. D. Y. D., age 40, stopped his truck on the highway in front of his home and was about to change a casing. He saw a bus and a car coming in opposite directions at a rapid rate toward him and, because he feared they would collide near him, he took the casing inside his yard and in a standing position with the body bent forward was examining it. The cars came on full speed and, when the bus driver saw that a collision was inevitable, he chose to avoid it by leaving the road. The bus passed through the fence and either a headlight or a fender struck the man in the left chest, knocking him down and moderately contusing the soft parts over the sixth, seventh, eighth, and ninth ribs in the midaxillary line. No ribs were broken.

A physician was called, found the man in extreme agony, and administered one-fourth grain of morphine hypodermically without perceptible relief. He then brought the patient to a small hospital where he received another quarter grain of morphine. On reaching the hospital about 2 hours after the accident I was shown a skiagram of the chest (Fig. 1), which presented some very puzzling aspects; upon a little study, the conclusion was reached that only a ruptured diaphragm and escape of stomach into the left pleural cavity could account for the replacement of lung shadows with a sac of much lighter density, containing no markings except its very definite outline, the upper border reaching almost to the clavicle, and for the displacement of the heart to the right.

The patient was then seen and examined. His agony continued unabated. His countenance was anxious, respiration labored, abdomen rigid, board-like; constant nausea and efforts to vomit were present, but without result. His attendants said that this had been continual since the injury, nothing ever being raised. The right side of his chest expanded abnormally on inspiration, the left

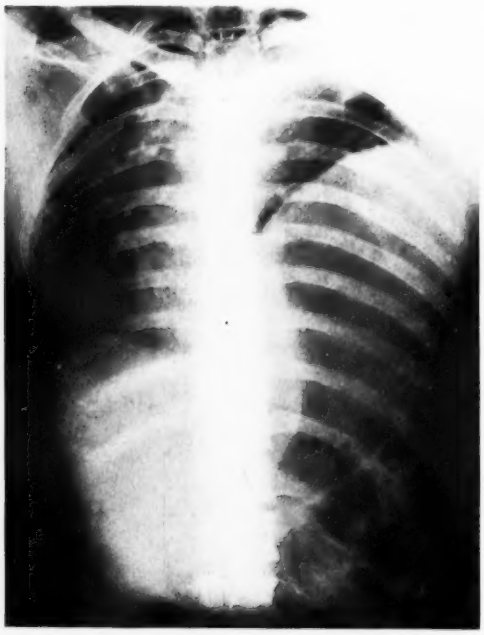


Fig. 1. Roentgenogram of chest showing lung high in left pleural cavity.

Fig. 2. After patient had swallowed a small amount of barium. The course of the œsophagus is easily seen.

[1]Read before the Southern Surgical Association, Biloxi, Mississippi, December, 1926.

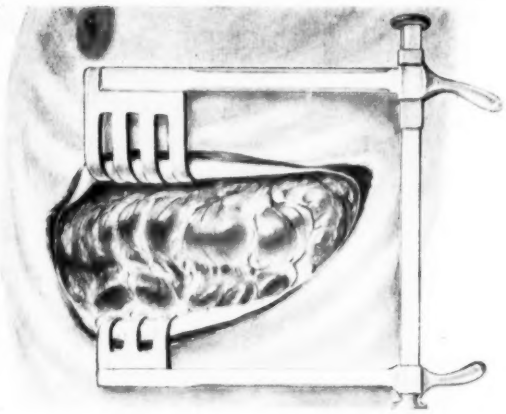


Fig. 3. Colon and omentum presenting in the wound when chest was opened.

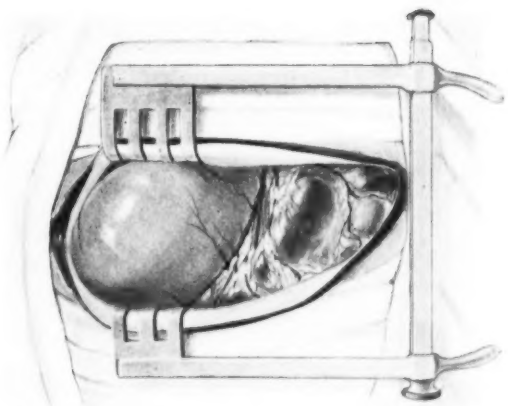


Fig. 4. Showing stomach after retracting colon downward to left.

side not at all. The lower margin of the ribs seemed to be pulled slightly downward and to contract rather than to expand on inspiration; the intercostal spaces did not become depressed. The heart was displaced to the right of the midline. The whole left chest was tympanitic; this was more clear cut in the upper chest. The man, when not retching, was crying for water. He could swallow water without difficulty, and the tinkling sound of its entrance into the stomach could be heard most clearly in the apex of the axilla and in the subclavicular fossa. The pulse was 120; respiration 28; blood-pressure 108–65.

On account of the gravity of the condition, I felt that I could give him a better chance by removing him to Vanderbilt Hospital and operating there. Consent to this was given.

On reaching Vanderbilt Hospital, the X-ray examination of the chest was repeated with an identical result. He was then given a small amount of barium stirred in water, which showed the stomach to be in the chest cavity and also showed the course of the œsophagus downward, curving sharply to the left and then upward. This was indicated by a faint light streak, which should have, if it had been seen in the early examination of the plate, given me and my consultants a better understanding of the actual state of affairs. Unfortunately this curved white line was seen only after we knew the relation of the structures in the chest. The barium that was swallowed entered the stomach and accumulated in a pool on the posterior wall.

The question then arose as to whether operation should be undertaken immediately. On account of the possibility of dire complications, and with a fair pulse and blood pressure, it was considered that immediate operation would probably give him the best chance.

The anæsthetic was gas and ether.

An incision 7 inches long was made in the left seventh interspace. When the pleura was opened omentum was encountered first, covering both large and small intestine; behind and internal to these was the stomach (Fig. 3). Passing the hand into the chest, we could move the stomach downward into the abdominal cavity; the outline of the opening between the two cavities could not be determined. An effort was made and repeated several times to replace the viscera into the abdominal cavity; in every instance it proved futile. The difficulty of replacing the viscera was due in part undoubtedly to the fact that the patient could not be relaxed by the anæsthetic. (I have had one other diaphragmatic injury in which the same observation was made, although he received only ether.) As soon as partial reduction was accomplished the organs would escape from the grasp on the least motion and rush back to the top of the chest as if under intense suction. The stomach was so tightly distended with gas that a trocar and cannula were inserted to collapse it. It refilled in a few minutes and aspiration was necessary a second time. The cannula was employed instead of the stomach tube because gas anæsthesia was administered. I am unable to state what influence the reversed action of respiration on intragastric pressure may have had on the accumulation of gas in the stomach. Schlippe has called attention to the fact that intragastric pressure rises normally with inspiration, but when the stomach lies in the pleural cavity the reverse is true. Consequently, it became necessary to open the upper abdomen, making an incision 6 inches long just to the left of the midline. While my first assistant pulled the viscera down and out, I made pressure above. Replacement was easy; but as soon as the stomach was released it promptly returned to the top of the pleural cavity.

When the abdominal organs were reduced to their cavity it was found that the diaphragm had been avulsed from its attachment to the left chest wall a distance of about 10 inches (Fig. 4); that no vestige of it had been left attached to the wall, so that passage from pleural cavity to abdominal cavity was just as smooth as if no partition had ever been present; that this large wing of diaphragm had curled up into the chest cavity with the œsophagus circling around its under surface, and the free edge of the diaphragm, ragged, about ¾ inch thick with a projecting ledge of pleura above and of peritoneum below extended anteroposteriorly across the pleural cavity, mediastinum to its right (pleural) surface, abdominal viscera to its left (peritoneal) surface. This position gives an explanation of the patient's ability to swallow and inability to vomit, for the fixation of the œsophagus below and the high elevation of the fundus caused a bend of the œsophagus at the cardia to an acute angle, which easily admitted entrance to, and quite as effectively prevented exit from, the gastric cavity.

Within the pleura the lung was high, internal, collapsed. There was about a pint of dark blood in the pleural cavity.

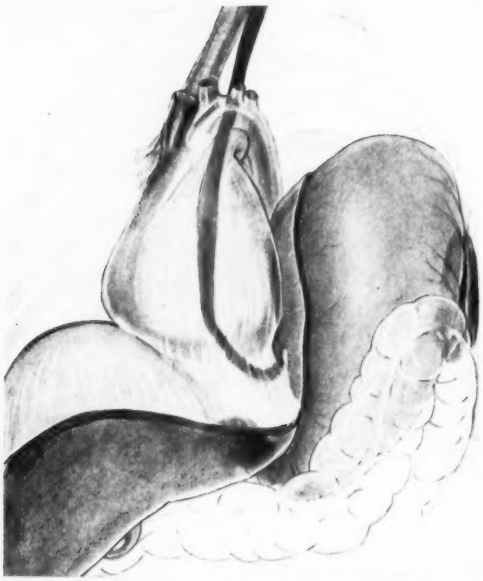


Fig. 5. Showing the free margin of the diaphragm to the right of the stomach and the displacement of the thoracic viscera.

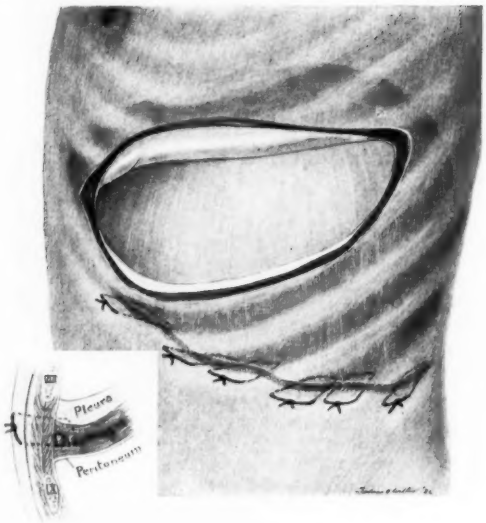


Fig. 6. Mattress sutures holding margin of diaphragm against inner surface of chest.

No bleeding vessels were discovered. Practically the whole stomach, the transverse colon, the great omentum, the spleen, and numerous coils of small intestine were in the pleural cavity.

Upon reduction of the viscera and discovery that, instead of being ruptured, the diaphragm was avulsed, a new problem presented, namely, that some plan must be devised to suture a free edge to a flat wall. It did not require long to conclude that it could be done only with through-and-through mattress sutures (Fig. 5). In this way the diaphragm was brought into contact with the chest wall and held. The sutures were passed through skin and chest wall into the pleural cavity, through diaphragm, again through diaphragm, through chest wall. They were tied on the skin side. Because of the ease with which omentum insinuates itself into very small crevices left after suture of the diaphragm, these sutures would, to be efficient, require close apposition, if, indeed, they could be made to hold at all. I had no precedent for this method of closing the rent, but can imagine no substitute for it. James F. Mitchell operated on a diaphragmatic hernia in which he thought direct approximation insecure because he could not insert the sutures far enough from the edge. Consequently he dissected the skin up on one side of the incision and inserted sutures through both limbs of the rent in the diaphragm and the chest wall.

The wounds in chest wall and abdominal wall were now closed. The patient died shortly after the work was completed, before he was removed from the table.

Postmortem could not be obtained.

The nearest approach to this case is diaphragmatic hernia or rupture. Surgeons choose one of the three possible methods of approach for closure of these openings, the abdominal, the thoracic, and the two combined. Judging from the assurance with which the former two groups recommended the route of their choice, one must consider that there are cases in which the chosen routes were satisfactory. Those who recommend the combined route, as I have shown in the case reported, have most meritorious reason for insisting upon this plan, because reduction could not be accomplished and closure made by the single route. It seems that this should be the rule in large openings with escape of large portions of viscera into the pleural cavity; and that, if with either of the single routes reduction should prove difficult, no time should be lost in further efforts, but that a companion wound should be made at once in the abdomen or chest respectively. Such delay and the attendant efforts at reduction cannot fail to increase shock and mortality.

The question naturally occurs, *post facto*, whether, if this man had lived, the union of the diaphragm to the chest wall would have been secure enough to withstand the tension imposed by coughing, sneezing or heavy straining; and, since there is doubt in my mind on this point, I am sure that in a similar case the mattress sutures should be heavy silk or linen instead of chromic catgut. Would the ordinary respiratory movement of the diaphragm not interfere with such healing, as in other parts of the body where constant or repeated traction of muscles on sutures is

an almost certain guarantee of failure? This traction of course, could be avoided by doing a phrenicotomy, the only disturbing factor being the rhythmic rise and fall of the paralyzed leaf on inspiration and expiration. This, if it accomplished union, would do so at the cost of permanent loss of 300 or 400 cubic centimeters of lung capacity.

The tendency for intra-abdominal viscera, especially omentum, to insinuate themselves into any crevice on the diaphragm raised a doubt whether the origin of this muscle could possibly be sutured so closely as to prevent this accident, which, if it should occur, would mean failure.

It has been demonstrated that the lateral portions of the diaphragm which lie in contact with chest wall heal more surely than the rest of it; and that wounds heal more readily when they are parallel to the muscle fibers than when transverse. It has even been claimed by Iselin and also by the Brazilian Repetto that they could in no instance obtain union of wounds transverse to the fibers in the dog's diaphragm. Naegeli disputes this, claiming that the chief causes of failure are accumulation of air, serum or blood in the pleural cavity, or anything that prevents contact of the lung with the parietal pleura.

It is interesting to conjecture why this peculiar accident occurred under circumstances which usually, one might almost say normally, should result in rupture of the diaphragm. The causes of rupture of the diaphragm are given as sudden pressure or blows upon the chest or abdomen, and the result is rupture, not avulsion. Something unusual, some extraordinary group of factors must have combined in this case to cause severance in the thickest, strongest and most extensive line to be found in the midriff, namely along its peripheral attachment, or its origin from the chest wall. It seems as if it must have been sheared from its attachment, and I think this is precisely what happened; that the lungs were filled with air; the man saw he would be struck and very naturally braced himself by tightening every muscle of his body; this included both abdominal muscles and diaphragm, the latter contracted under heavy tension in its horizontal plane, bolstered above by the overfilled lung, below by abdominal viscera; the edges of the distended lung reached downward nearly, or quite, to the angle between chest wall and the diaphragm. The blow came like a flash, the lung was compressed and forced to expand along the line of least resistance and the sharp edge of the lower lobe virtually sheared the diaphragm from its moorings. In other words, while neither of the forces could have produced such an injury, the combination of traction, fixation and shearing served effectively to convert the most resistant part of the muscle into the weakest.

SUPRAPUBIC PROSTATECTOMY

Complete Exposure through a One and One-Quarter to One and One-Half Inch Incision; Operative Results and Technique[1]

By S. HARRY HARRIS, M.D., Ch.M. (Sydney), F.C.S.A., Sydney, Australia
Honorary Urologist to the Lewisham Hospital

SUPRAPUBIC prostatectomy, since its wide popularization by Freyer, has been the subject of endless discussion. At different times and in different clinics innumerable variations and modifications of technique have come and gone. In the past most of the operations have been of a blind nature, being performed entirely by touch, unaided by vision. Latterly the trend has been decidedly toward the performance of an "open" operation, the field being more or less completely visualized. The very wide incisions practiced by some surgeons both at home and abroad admit almost a complete daylight exposure.

Were it the sole desideratum, this wide exposure would doubtless be the choice of most operators. Many other factors, however, must be taken into account, of which the most important are: (a) primary wound union, (b) postoperative pain, (c) limitation of respiratory movement, and (d) abdominal distention.

On each of these counts the new wide exposure compares unfavorably with the old "blind" operation through a small incision. This latter operation, however, presents so many obvious disabilities that it is rapidly falling into desuetude.

The operation which I have devised and practiced now for several years aims at a combination of the good points of both and the bad points of neither. It allows a complete visual exposure through a one and a quarter to one and a half inch incision and is applicable to both one and two stage operations.

During the 13 years ending December 13, 1926, the operation described has been performed, with some important variations, 433 times with 16 deaths within 1 month after operation; a mortality rate of approximately 3.6 per cent. In the last 4 years and 10 months of this period there were 245 operations and 7 deaths, a mortality rate of approximately 2.8 per cent. There has been also during this period a very marked corresponding improvement in both immediate and remote results.

All cases are now subjected to a one stage prostatectomy when it is practicable. Preliminary bladder drainage is effected, preferably by a retention catheter, if renal function is defective. In the occasional case when catheterization of any kind is either impossible or intolerable, and when sufficient improvement does not follow catheterization, a temporary suprapubic cystotomy is done commonly through a 1 inch transverse incision. The glass tube which is habitually employed for drainage of the bladder (Fig. 11) is replaced about the sixth day by a Pousson self-retaining rubber catheter.

The second stage is deferred for several weeks until the patient has regained a reasonable measure of health and is able to walk about without effort.

In no case is prostatectomy undertaken, whatever the other findings, unless the indigocarmine test is deemed satisfactory. For this purpose 4 cubic centimeters of 4 per cent solution are given by intramuscular injection or 4 cubic centimeters of 0.8 per cent solution intravenously.

The postponement of the second operation for at least 1 month after the first has several advantages. It obviates the long confinement to bed necessitated by the performance of the two operations in rapid succession, and, with the disappearance of wound rigidity, permits with slight variation of the usual technique (Fig. 1), almost as ready visualization of the field as obtains in the one stage operation.

From experience it may be definitely stated that equally as good exposure of the prostatic environs is obtainable through the small incision described as through a larger, and any procedure indicated in this area is, with the technique described, equally as readily carried out. If during the course of the operation conditions arise which demand a wider exposure, it is a simple matter to enlarge the incision to any desired extent. In my experience, however, this is rarely necessary.

OPERATIVE TECHNIQUE

Suprapubic prostatectomy under intrapharyngeal or intratracheal anæsthesia was carried out in practically all the cases of this series. The so-called intra-urethral method of enucleation of the prostate, which leaves the veromontanum and ejaculatory ducts intact, was the procedure of election.

[1] Presented with moving picture demonstration of actual operation before the Australasian Medical Congress at Dunedin, New Zealand, on February 7, 1927.

The bladder is washed out with 1:3000 solution of nitrate of silver, emptied as completely as possible, and the catheter removed immediately before the patient is brought to the operating theatre.

The patient is placed in a low Trendelenburg position and a transverse suprapubic incision made through the skin and fat, varying with the obesity of the patient from 1¼ to 1½ inches in length. The aponeurosis is slit vertically in the midline for a similar distance. The rectus muscles are separated and the bladder picked up with tissue forceps. The peritoneal reflection is pushed up to the topmost point of the bladder, successive pairs of forceps being applied to the bladder wall until this point is reached, when only the highest pair remains. The bladder is now drawn well up into the incision and acts as an effective plug should, perchance, any residuum of lotion or urine escape during the next step (Fig. 2).

The bladder is incised between the forceps by careful layer dissection until the mucous membrane is reached. This is picked up with dissecting forceps and nicked to an extent sufficient only to allow the immediate insertion of the nozzle of an electric suction tube (Fig. 3). When the bladder is completely empty the suction tube is removed and the incision lengthened to admit 2 fingers. There has been no soiling of the wound by urine or lotion.

Careful digital exploration and, if deemed advisable, visual inspection of the bladder is next made and calculi, if present, are removed (Fig. 4).

Fig. 1. Vertical incision 1 inch in length employed when there has been a preliminary cystotomy. This provides adequate exposure with the technique described.

Bimanual enucleation and removal of the prostate are then proceeded with.

With proper arrangement of sheets and towels and the use of three gloves on the left hand, which are successively removed by an assistant when

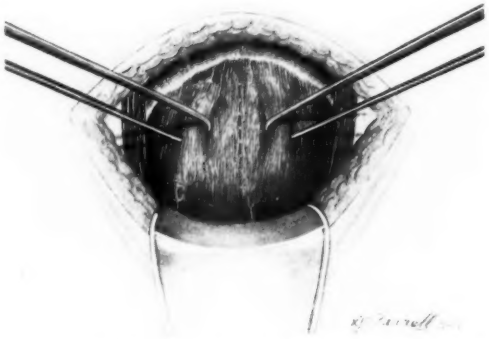


Fig. 2. Bladder exposed, ready for incision. Peritoneal reflection well shown.

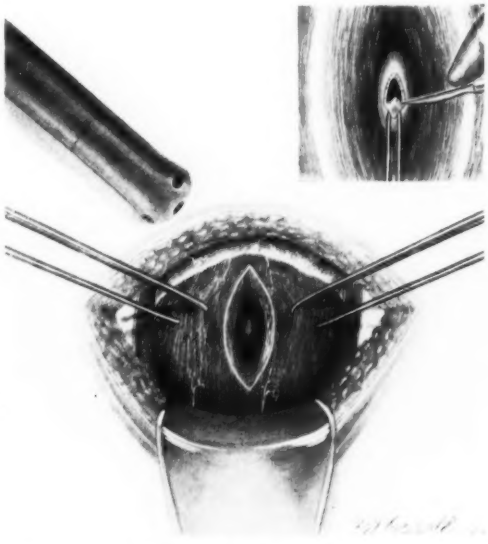


Fig. 3. Layer dissection of bladder. Nozzle of "sucker" ready for insertion. Inset: Method of cutting mucosa.

D J Farrell 1926

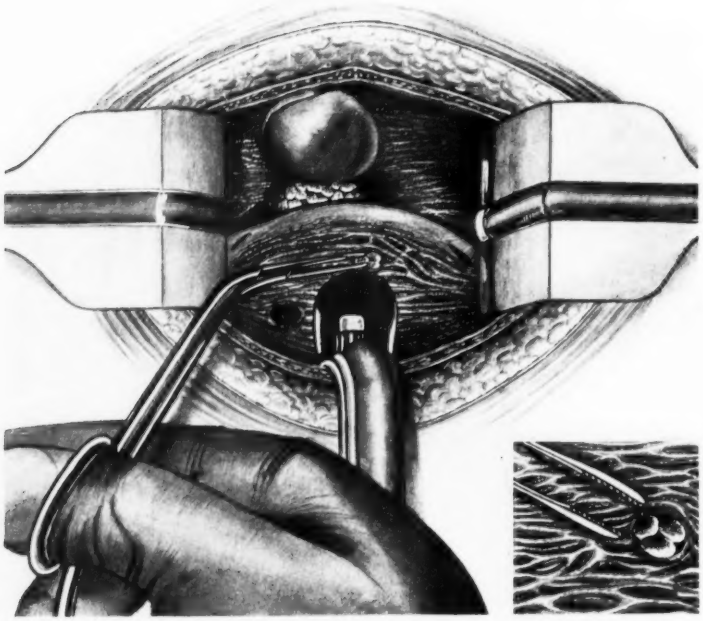


Fig. 4. Author's electrically lighted bladder retractors in position. Anterior retractor omitted for the sake of simplicity. Nest of small calculi seen in deep post-prostatic fossa. Inset: Removal of calculi from diverticulum shown in main figure (enlarged).

soiled, no contamination of the operative field takes place, even after manipulation entailing removal and reinsertion of the first and second fingers of the left hand into the rectum.

The electrically lighted bladder retractors, which I have had constructed, are now placed in position. These consist of a set of 6, 4 of which are generally used in any given case. They vary in size, shape, and length. The longer blades are necessary when we are dealing with obese patients with deep pelves. All have the Thompson-Walker type of handle and are electrically adapted and interchangeable. These permit a thorough inspection of the bladder neck. This is carefully reviewed and any necessary trimming performed (Fig. 5).

After bleeding has received any requisite attention (*vide infra*), the single extended figure-of-eight suture of No. 3 plain catgut is placed (Fig. 6) to embrace, in order, the cut edges of the bladder, the fibrous and muscular coats of the bladder, and finally the rectus muscles and aponeurosis.

The special glass bladder drainage tube (Fig. 11), is then inserted and the suture drawn tight and tied (Fig. 7).

The operation is now complete, the tube snugly filling the abdominal wound (Fig. 7 and 8). Occasionally a Michel clip may be placed with advantage in the skin on one or the other side of the flange of the drainage tube.

The dressings are applied and the glass drainage tube fixed firmly in position by zinc oxide strapping placed outside the dressings in such a way that the glass connecting tube may, if necessary for the removal of clots, be disconnected from the rubber piece on the top of the bladder drainage tube without disturbing the dressings.

Control of hæmorrhage. When special measures for operative control of hæmorrhage were necessary, which was exceptional, bimanual compression usually sufficed. In some cases suture of the bladder neck was practiced, in others the prostatic cavity was packed with 3 inch sterile gauze which

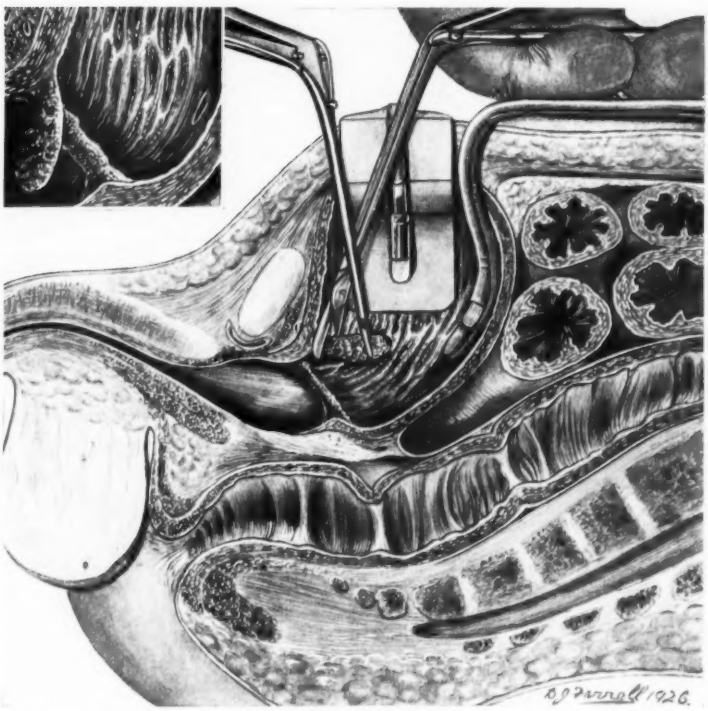


Fig. 5. Sectional view. Removal, from anterior region of sphincter, of adenomatous nodule discovered during systematic review of prostatic cavity after prostatectomy. Inset: Enlarged view of nodule in natural position.

was removed in 1 to 3 days depending on the attendant discomfort. Suture of the bladder neck was found to be of such value that it is now used as a routine in both the one and two stage operations. It is of importance, both for immediate hæmostasis and to ensure satisfactory after results, that a complete clearance be made of the prostatic cavity and bladder neck, and that the roof, that is to say, the region of the vesical sphincter or trigone, should be enabled to fall in on the prostatic cavity without tension. Thus when a small tight sphincter or a considerable remnant of slack in the trigonal region remains after the removal of the prostate, it is deeply divided backward in the midline, one stitch being placed by a special needle which I have had constructed (Fig. 10), in each side of the incision, as shown in Figure 9, to prevent reunion of the cut edges. If a thick, fleshy trigonal shelf is present a wide wedge is cut out and the edges sutured. Furthermore, unless these precautions are adopted "collar" or "ledge" formation is liable to occur and lead to persistence of obstruction or its recurrence at a later date.

The omission in the "blind" operation of these precautions and the impossibility of their observance is definitely associated with increased liability to hæmorrhage, both immediate and remote, to sepsis, and to delayed closure of fistulæ. These, indeed, constitute in the main the *raison d'être* of the new operation.

Instruments of a particular type are essential for the accurate and facile performance of this work through the restricted incision described (Figs. 4, 5, 9, and 10). Most of these have been specially constructed for me in Sydney.

POSTOPERATIVE TREATMENT

Half a pint of salt solution is given per rectum immediately after the patient is returned to bed and a bandage fixed in position to ensure scrotal suspension. A hypodermic injection of morphia grain 1/6 is given as the patient is regaining consciousness and repeated as often as required.

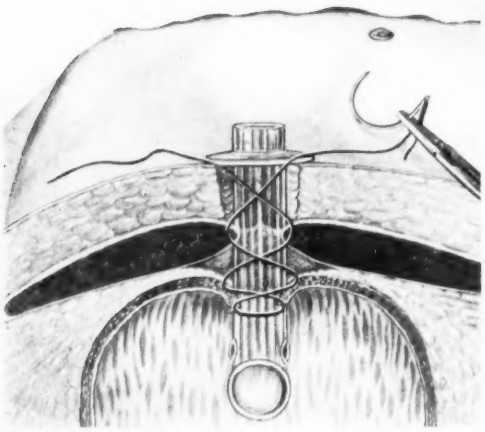


Fig. 6. The single extended figure-of-eight suture used for wound closure, before being tied.

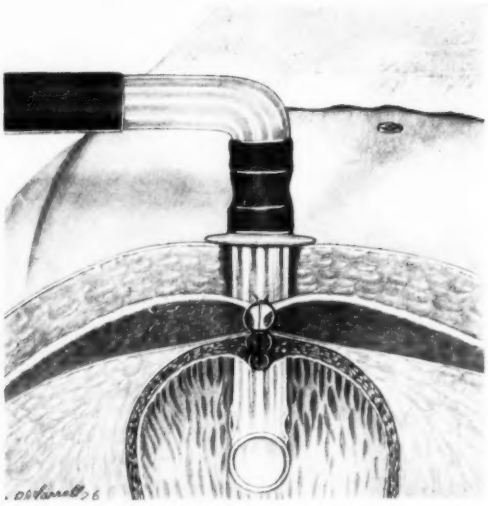


Fig. 7. Suture drawn tight and tied. Glass drainage tube, ¾ in. caliber, in position. Operation complete.

The patient is propped up in bed as soon as complete consciousness is regained.

On the morning of the fourth day after the operation 1 ounce of castor oil is given by mouth and 6 ounces of warm olive oil run slowly into the rectum. No further rectal manipulation of any kind is permitted during the first fortnight of convalescence.

The abdominal dressings are changed if necessary after 24 hours. After this they rarely require attention until the removal of the bladder drainage tube, about the sixth day. The removal of the tube leaves a clean, red, granular sinus which rapidly collapses, in most cases allowing the skin edges to fall together. A linear scar, generally not more than 1 inch in length, results, and, to all

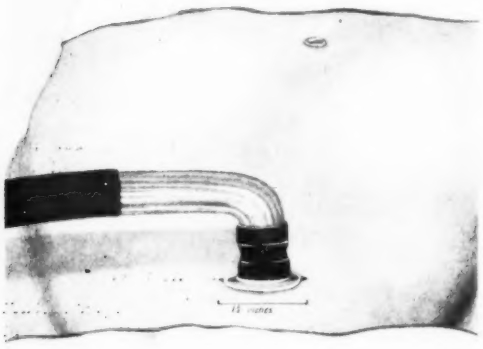


Fig. 8. Operation completed through 1¼ inch incision, which the tube snugly fills. No skin sutures required.

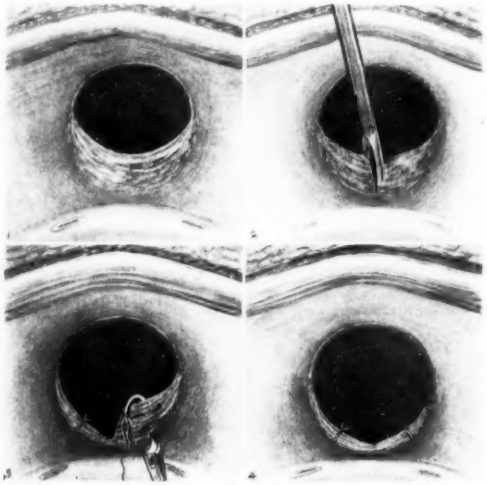


Fig. 9. Redundant tissue in trigonal region after prostatectomy, showing method of bisection and suture.

Fig. 10. Author's bladder-neck suture needle. This is an adaptation of Lane's cleft palate needle and is longer and more slender than Young's "boomerang" modification. (⅔ size).

Fig. 11. Author's glass bladder drainage tube (½ natural size).

Fig. 11.

intents and purposes, also a normal abdominal wall. Patients are generally out of bed on the tenth day. No bladder irrigation of any kind is employed, at any rate during the first fortnight, beyond a superficial irrigation of the sinus immediately following removal of the drainage tube. After this if the urine is "dirty" and has failed to respond to the usual hexamine and sodium benzoate, catheter irrigation of the bladder with nitrate of silver is practiced for a few days.

Onset of micturition. On the second day after the removal of the tube patients are given a urinal and encouraged to make effortless attempts at micturition 3 or 4 times daily. The large majority succeed by the eighth to the twelfth day and are quite "dry" from 3 to 7 days later. Should no urine be passed by the fourteenth day, a steel sound is passed. As a matter of interest it may be stated that there were 4 among the last 160 cases who, despite the sounding, failed to pass urine, and in whom on the seventeenth day a rubber catheter was tied and left for 2 days. All were nervous, feeble old men and in none was there any other apparent reason for the delay. In no case of recovery in this series was the onset of micturition delayed beyond the twenty-first day, in 1 only beyond the nineteenth.

CONCLUSIONS

The methods described admit of a complete, clean cut, visualized operation, and present, I venture to think, several novel features, the details of which have been planned to enable a maximal exposure with a minimal amount of trauma. The discomfort following operation is thus very largely obviated and wound healing expedited.

The operation while doubtless presenting greater technical difficulties than those usually performed and requiring an armamentarium of, and a certain familiarity with, instruments of a special type, will I believe, by its decreased mortality and morbidity rates, well repay the meticulous care demanded in its performance. With experience the complete operation can be performed in from 15 to 30 minutes and with so little disturbance that the convalescence in most cases resembles that of a minor operation and might possibly seem incredible to one who has not observed the results.

A fairly lengthy experience with the plan of campaign outlined shows that shock, sepsis, uræmia, and pneumonia almost can be excluded as operative risks. Hæmorrhage will still very occasionally require attention. There remains the cardiac or vital factor, practically the sole indefinable risk. Gradual or rapid circulatory failure from the seventh to the twenty-first day, when it occurs, is in my experience the most fatal of all complications. It is in effect the end of life. When or whether it will supervene in any of these old men none can certainly foretell.

ILEOCÆCAL INTUSSUSCEPTION IN INFANTS WITH SPECIAL REFERENCE TO FLUOROSCOPIC FINDINGS

By VIRGIL R. STEPHENS, M.S., M.D., Berwyn, Illinois

UP TO the present time X-ray studies in acute intussusception in infants have been very meager. This may be due to the relative infrequency of the condition, as suggested by Meyer and Brams in a review of cases in Cook County Hospital, Chicago, in which only 6 operative cases of intussusception were tabulated from the records of the last 6 years. Clubbe, of Sydney, Australia, however, publishes a series of 270 personal cases, by far the largest number in any report available. The high mortality still attendant upon this condition suggests the need of more attention to the early diagnosis and treatment. Clubbe reports a mortality of 20 per cent; Smith, 40 per cent; Birkenfeld, 30 per cent; Gibbon, 10 per cent.

A few attempts have been made to make use of the fluoroscope as an aid in the diagnosis of acute ileocæcal intussusception. Regnier states that up to the time of his report in 1924, ileocæcal invagination had been demonstrated by opaque enema but twice; the first instance being Lehmann's case in 1914, and the second that of Muff. Muff describes a fluoroscopic picture showing a barium column flowing without interruption to just beyond the splenic flexure, and at that point a shadow extending from the normal colon to the right side of the spinal column, which could only have arisen from the small bowel. Regnier's case was that of a 13-year-old girl with onset of symptoms 2 weeks previously. The opaque meal showed stenosis proximal to the invagination and absence of the cæcum and colon. The barium enema showed division of the contrast medium into two cylinders corresponding to the inner and outer lumen of the intussuscepted area. Distally, an outer cylinder was characterized by a thin mantle-like deposit with circular stripes showing a distended colon with deep haustra and less than normal space between. Proximally, a small caliber cylinder corresponded to the intussuscepting portion.

All of these cases, however, were older children and young adults, and the examination was made several days after the onset of symptoms.

Birkenfeld states that the X-ray findings are characteristic and explains them by referring to the work of Muff, Regnier, and Lehmann. Grise suggests that the fluoroscope may show a "cone-shaped" column near the intussusception but gives no illustrations. Abt states that X-ray examination should not be made on account of the incident trauma unless the diagnosis is uncertain. He says that the enema ends abruptly in an outline suggesting that of the apex of the intussception, its sheath presenting further evidence of the nature of the obstruction. Just what the appearance is he does not definitely state.

The writer has operated on 6 cases of ileocæcal intussusception in infants under 1 year of age with 1 hospital death. The fatality occurred on the seventh day following operation and was preceded by a series of convulsions and the general picture of acidosis. There was no evidence of recurrence.

Autopsy was not permitted. According to Birkenfeld death usually occurs within the first 2 days. He had no mortality after 6 days in over 50 cases.

Fluoroscopic examination with an opaque enema was made in 3 cases with very gratifying results.

Case 1. Baby D. M., age 3½ months, observed 6 hours after the passage of blood from the bowel, had a very definite sausage-like tumor on palpation but had had no colic. On account of the unusual clinical picture this case was reported.[1] When the barium mixture reached the upper sigmoid it took on a wide concave presenting surface, meeting the intussuscepting bowel with two definite horn-like projections as the barium insinuated itself around the so-called "outer cylinder." When more barium was allowed to flow, this presenting column traveled oralward at a rather rapid rate until it reached the hepatic flexure, maintaining practically the same contour on the presenting surface. A second palpation revealed no tumor in the epigastrium. Immediate laparotomy showed the intussusception to have been reduced as far as the hepatic flexure by the barium mixture.

Case 2. R. J., a boy of 11 months, had bloody stool 3 hours before examination and beginning colic 11 hours before. The contrast medium flowed rapidly until it was about two-thirds of the way across the transverse colon, when the concave presenting surface appeared. A film taken a minute later verified the observation. No reduction was accomplished nor attempted in this case. Immediate operation verified the position of the invaginating parts as seen in the roentgenogram (Fig. 1).

Case 3. A. J., a fat male infant of 10 months, was brought to the hospital 4 days after a sudden attack of colic and referred to me by Dr. F. C. Becht. The symptoms had consisted chiefly in the vomiting of almost all food taken and there had been two loose stools passed on

[1] See Stephens in Bibliography.

Fig. 1. Baby R. J., male, age 11 months, 11 hours after the beginning of colicky pains. Showing barium enema column meeting the intussusception in the transverse colon.

Fig. 2. Baby A. J., male, age 10 months. No sausage tumor palpable. Onset 4 days previously. Showing barium enema meeting intussusception at the hepatic flexure.

the day of entrance, the last being slightly streaked with blood and mucus. The child did not appear acutely ill and the symptoms of obstruction were conspicuously absent. No tumor mass could be palpated. On fluoroscopic examination with barium, the enema ascended rapidly to the hepatic flexure where the typical outline appeared. Increase of pressure produced evidence of pain but failed to advance the column. The barium was allowed to escape which it did almost immediately with only a few sprinkles remaining in the bowel. The injection was repeated with the reproduction of the same picture. Films were made while the enema tube was held in and the back pressure kept up. Laparotomy was advised on the basis of the X-ray findings and revealed the intussuscepting mass occupying the ascending colon. The colon was lying snugly against the right lateral wall of the abdomen and therefore could not be palpated. The small bowel was collapsed, showing that obstruction may be of low grade for several days after invagination has taken place. The reduction was easy and there was no necrosis. This patient probably would have succumbed with a diagnosis of colitis had not the fluoroscopic picture given the correct interpretation of the situation.

No "inner cylinder" of barium was observed in any of these cases. This finding of Regnier may have been the result of the opaque meal which had previously been given. At any rate no barium enters the inner lumen during the first few minutes after injection.

The characteristics of the fluoroscopic picture as observed in these 3 cases were:

1. An enlargement of the caliber of the barium column as it approached the intussuscepting mass.

2. The definite tendency toward the formation in the opaque medium of a concave presenting surface with pointed edges. This was true whether the force was sufficient to move the intussuscepting mass backward or not.

3. A thin, somewhat cone-shaped sprinkling of barium in front of the concavity which probably corresponds to the so-called "mantle" of Regnier and represents the advancing rim of the barium cylinder. The main facts are illustrated in the accompanying roentgenograms (Figs. 1 and 2).

It would appear that the fluoroscopic examination should be of diagnostic value in cases with doubtful history or physical findings. It may be of service in partly or wholly reducing the intussusception and at the same time proving the result.

BIBLIOGRAPHY

ABT. Pediatrics, iii, 547.

BIRKENFELD, W. Ueber die Darminvagination im Kindesalter. Arch. f. klin. Chir., 1925, clxxxvii, 356.

LEHMANN. Ein Fall von Invaginatio ileocaecalis im Roentgenbilde. Fortschr. a. d. Geb. d. Roentgenstrahlen, xxi, 115.
MEYER, K. A., and BRAMS, W. A. A clinical study of acute intestinal obstruction. Illinois M. J., 1927, li, 43.
MUFF, E. Das Roentgenbild der kronischen Darminvagination. Beitr. z. klin. Chir., 1920, Ed. 118.
REGNIER, E. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1924, xxi, 697.
STEPHENS, V. R. Acute Intussusception without pain. J. Am. M. Ass., 1927, February 12.

A NEW AND PRACTICAL ABDOMINOSCOPE

BY W. O. SWEEK, M.D., F.A.C.S., PHOENIX, ARIZONA
St. Joseph's Hospital

FAILURE to make a correct diagnosis, in abdominal conditions, is still the cause of many deaths. The ineffective X-ray has been of some help to the clinician, but the exploratory laparotomy is still too frequently performed. It is for the purpose of giving the diagnostician visual access to the peritoneal cavity that this instrument was devised. This instrument is of value to the surgeon in every adbominal operation. He is able to visualize the abdominal condition and place his incision accordingly. It is valuable in splanchnic block with local anæsthesia; it gives an opportunity for careful inspection of the abdominal contents without disturbing or dragging upon them; it makes appendectomy, in interval cases, a simple procedure requiring a one-half inch puncture wound.

The technique of using the instrument is simple. A one-half inch incision is made to the right or left of the midline, approximately one inch. All oozing and bleeding is controlled before the peritoneum is opened by a sharp pointed hæmostat or scissors, according to the technique of the operator. The instrument is then inserted, left in the abdomen for a few minutes until the patient is accustomed to its presence, and all abdominal reflex action ceases. If the patient is under a general anæsthetic, the surgeon can proceed at once with his examination. It gives a visual field in the form of an oval (2½ by 2 inches) which is sufficiently large for all purposes. It can be used in all cases of doubt in which an exploratory operation would be required to make a decision and it should be used as a routine procedure in all abdominal operations as it permits inspection of many of the inaccessible areas now examined by palpation by the surgeon's hand which, in most instances, is about as good from the outside as it is from the inside.

We are using this instrument, at present, in every abdominal case as it helps us place our incision, thereby shortening the length of the incision. It also enables us to place the incision more accurately and obtain a far more accurate knowledge of abdominal pathology than we would possibly obtain by any other method.

The largest diameter of the tube is 1 centimeter and the length of the tube is about 32 centimeters. The instrument consists, essentially, of a tube about the diameter of a fountain pen; about the outside of this tube there is another tube of very thin material which slides freely upon the first tube and which is actuated by a screw with a

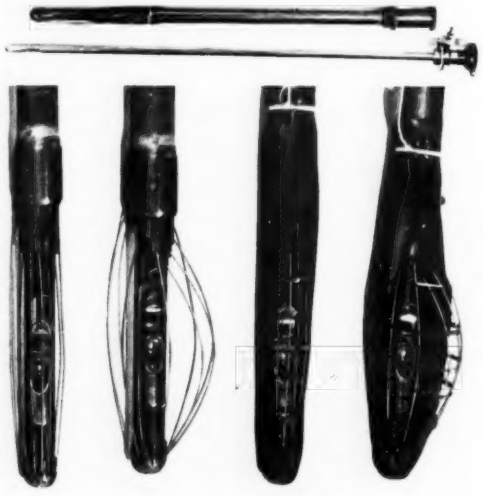


Fig. 2. Fig. 3. Fig 4. Fig 5.

Fig. 1. (Above) Instrument assembled ready for use.
Fig. 2. Shows the detail of the distal end.
Fig. 3. The distal end expanded.
Fig. 4. Instrument incased in glove finger.
Fig. 5. Instrument expanded.

large knurled nut at the upper or outer end of the instrument. When this nut is turned, the outer tube is moved along on the inner one and engages first the center one of the small slides near the lower end of the instrument. This slide is thus moved along in its groove and the spring wire, which is hinged in the slide and also at the extreme end of the instrument, is thus bent outward into a slight arc. As the outer tube is further moved, it engages another slide on either side of the center one and thus two more wires are bent, although to a lesser extent than the center one. Further movement engages two more wires and they move and bend as the others do but to a still lesser extent. When the outer tube reaches the end of its travel, the several wires have formed an inclosure about the lower or inner end of the instrument and, at no place, are the wires sufficiently far apart to allow easy entrance to the inclosure. The nut may then be withdrawn and the whole mechanism returned to its original cylindrical shape. The wires are so hinged at each end that they work in guides which hold them in alinement and, at the same time, prevent the possibility of anything becoming pinched under the wires when they are flattened out.

The whole instrument may be easily and quickly taken down for cleaning and as quickly reassembled. It may be boiled or sterilized without in any way affecting its operation.

Inside of the instrument proper, a straight cystoscope is inserted and lighted and by this means the entire inner area of the inclosure may be minutely inspected through an opening in the tube.

We are using this instrument routinely and find it of immense value. Mr. R. T. Evans, who worked out the details of this instrument and perfected it, has so thoroughly completed his task that the instrument works easily and smoothly and is most durable and efficient.

THE USE OF THE OVERHEAD SUSPENSION IN TREATMENT OF FRACTURE OF FEMUR IN INFANTS

By H. D. SONNENSCHEIN, New York
From the Surgical Service, Harlem Hospital, New York.

THE care of fractures, in the majority of instances, does not usually come under the care of the surgical specialist. Only in the larger cities is it possible to segregate and hospitalize the fracture cases. The standard of results obtained will, therefore, depend upon the technique possible for the average physician to employ.

The extremes of age are productive of the two extremes in the results of fracture surgery, the best results being obtained in infants and children while the poorest results occur in the aged.

In the treatment of fractures in both the infant and the aged, the nursing and medical attention is of great importance, and often of the most importance, if the best results are to be secured. The physician, concentrating his efforts on the local injury, is apt to overlook this fact, and yet it is the apparently small details, conducive to the child's health and well-being, which contribute largely to the successful recovery, not only of the local condition, but also of the growth, nutrition, comfort, and mental welfare of the child. The child is naturally happy, and all means to keep it so must be paramount in the minds of those responsible for its care. Fortunately, infants and children react favorably to trauma. Their recuperative and reparative processes are at a maximum. Except in the more severe type of injury, and if no head or abdominal injury is present, they recover promptly from the primary shock. They are often more frightened than hurt.

Several other important factors must be borne in mind in the treatment of fractures occurring in infancy. It is well to remember that perfect anatomical alignment is not essential. Persistence of a certain amount of deformity is a less serious matter than it is with adults. In the course of a few years such deformities tend to be corrected by the process of growth; slight angulation can easily be corrected in the after-treatment by means of the convalescent brace. This must not be interpreted to suggest carelessness and neglect in the handling of the local condition, but only to encourage simplicity in the treatment. Above all, unnecessary and meddlesome manipulations must be avoided. Open reduction has no place in this type of fracture. It is never indicated. With this in mind, the local treatment should be so instituted as to allow for the general care of the patient, the feeding, so important in the very young, and the local and general hygienic care, which will keep the infant normal and hasten the ultimate recovery.

Several problems present themselves, more annoying than serious. Infants are constantly soiling themselves and the retentive apparatus. Their skin is extremely sensitive to irritation and infection. Their inability to comprehend, combined with their restlessness, disturbs the position of the splints. It is not unusual for children to remove a splint or plaster cast. They do not appreciate the seriousness of their condition, and we cannot expect the co-operation seen in an older child or adult.

Fractures of the femur occur in infancy as a result of indirect violence, usually due to a fall, and are invariably of the shaft. Cases have been reported as occurring during manipulative operative procedures. The majority of our cases occur in the spring and summer; at this time of the year the children are out of doors because of the heat and humidity, and frequently fall off fire escapes and porches. The fracture is usually complete, transverse or oblique, though some may be of the greenstick variety. A case of separation of the lower femoral epiphysis in an infant 3 months old has been seen by the writer. It has not been our experience that rickets, malnutrition or constitutional disorders predispose an infant to fracture. This communication does not include any discussion on the pathological fractures that occur as a result of deficient calcium metabolism, such as those that are seen in osteomalacia and fibrocystic disease of the bone.

The first step is to decide which particular closed method should be used. Only about four methods are described in most textbooks: (1) the plaster-of-Paris spica, (2) the Thomas splint with adhesive traction, (3) the padded wooden side splint, and (4) overhead vertical suspension.

There are many methods, and it is plainly evident that none is entirely satisfactory; there are as many advocates for one as there are for the other, and it therefore becomes a question of experience and results.

Briefly, the objections to the plaster-of-Paris method of treatment is that it is uncomfortable and is more so if poorly applied. There is the likelihood of secondary displacement occurring within the cast. The cast becomes soiled and requires renewal. It does not allow the child enough freedom to move about in bed. Then too, not all surgeons are adept in the handling of plaster-of-Paris.

The Thomas splint is most useful in adults. It is unexcelled as a transportation splint. With infants, however, this splint is not really satisfactory; the ones on hand are usually too large, and even if specially made, there is the possibility of the ring becoming soiled with urine and fæces; this, with the counter pressure on the tuberosity of the ischium causes excoriations and pressure sores.

The long side-splint is unstable; it becomes soiled, also does not allow for traction. The patient will disturb the position of this splint and even remove it. This is also true of the Thomas splint.

The overhead vertical suspension method overcomes all these difficulties, combining the true fundamentals in the treatment of fractures, namely, reduction of the deformity, traction and immobilization without absolute fixation. Vertical suspension aids lymphatic and venous drainage and adds to the comfort of the patient.

Except for a few simple changes, the method we use is the one originally described by Bryant. With a child properly suspended in the overhead frame, the general care of the patient is greatly facilitated; this is one of the outstanding features. The child cannot soil the apparatus, and its needs can be taken care of. A Bradford frame can be used in conjunction with the overhead suspension, but we have not found this necessary. In this position the limb is more easily radiographed. The frame is simple and easily constructed.

Many methods and modifications of the Bryant overhead suspension are employed, but simple measures have proved best. The apparatus we use is easily and inexpensively made by any carpenter, or if needs be, by the physician himself. It consists of two uprights, supporting a cross-piece; two pulleys are attached at the center of the cross-piece. A pulley is also attached to each upright, to carry the weights outside of the bed and away from the patient. Just enough weight to lift the buttocks off the bed should be used. This facilitates the use of the bed pan. Unless the child is unusually large, we have found that the average weight to use is about 5 pounds. It is better to suspend both legs; if only one leg is suspended, infants squirm, turn and twist, and in this way disarrange the traction. With both legs suspended traction is more certain and constant. If the child is too unruly or is one who keeps twisting and turning around, a cross-bar uniting the two spreaders can be used. We are now using this cross-bar as a routine measure. There is probably little choice as regards fixed or pulley traction; it is a matter of choice or custom. We have been in the habit of using pulley traction, as it accommodates itself better to changes in position assumed by the child than does fixed traction.

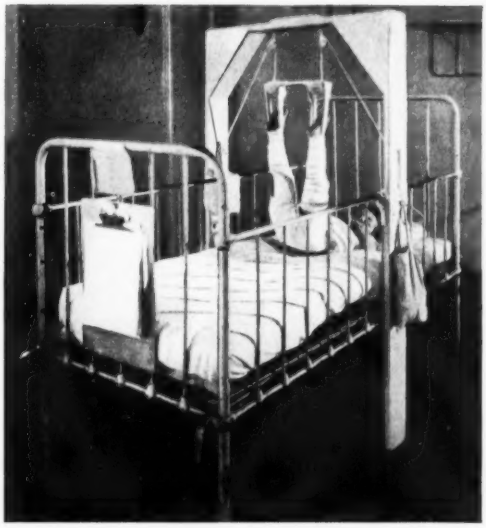


Fig. 1. Infant with fracture of left femur, suspended in overhead frame.

Traction strips are applied to the mesial and lateral aspects of the thigh and leg, extending from 1 to 2 inches above the line of fracture to below the foot, incorporating a wood "spreader" below the foot, which is wide enough to keep the adhesive from chafing on the malleoli, and to the center of which is attached the light line for traction. Only the best quality moleskin adhesive should be used; the edges of the adhesive should be nicked, to allow for smooth conformation to the skin surfaces. No preliminary preparation of the skin, except perhaps ordinary cleansing, is necessary. The crest of the tibia, the knee, and the head of the fibula should be protected with cotton padding. Additional fixation is secured by spiral adhesive strips over these lateral strips. A firm circular bandage covers all.

The child is left suspended from 3 to 4 weeks, at which time union is usually solid. There is a very rapid formation of callus. Even at the end of 1 week, because of this callus, it is difficult to change the position of the bones. After the removal of the suspension, the child is kept in bed for another 1 or 2 weeks, and weight bearing is allowed at the end of 8 weeks. With the average case no convalescent brace or apparatus is needed. Occasionally, if the callus is not entirely firm, if slight angulation remains, or if we are dealing with a too unruly youngster, a short plaster-of-Paris spica, or walking caliper, can be employed.

Our patients are wheeled out on to the porch, and also are given a cod-liver oil preparation daily. Such factors as fresh air, sunlight, and avoidance of infection are essential to the child's well being. The child may have the benefit of sunshine during the greater part of the day, weather permitting, if the bed is moved from time to time directly into the most sunny location. As a substitute, we suggest the use of the quartz lamp, and this, judiciously used, has proved of great value in hastening convalescence.

All the cases are carefully checked up with measurements and radiographs. Local massage and physiotherapy are unnecessary. In none of our cases has there been any limitation of the joint motion. It has never been necessary to remove the child from the frame, even though some of the patients developed complications such as measles, diphtheria, and bronchopneumonia.

For an analysis of 63 cases of fracture of the femur in infants, we were able to obtain a "comeback" report from 2 to 10 years following admission to the hospital. The overhead traction was used in all cases. The ages of the patients ranged from 4 months to 2½ years, and the sex was about equally divided. The average stay in the hospital was 36 days.

Fracture occurred in the right femur 33 times; in the left femur 29 times and in both once, making a total of 63.

Firm, bony union, with good, in fact almost perfect alignment, was obtained in 61 cases. Two patients had bony union, but with slight angulation; this was later corrected with a caliper brace. Excellent functional results, with no shortening, were obtained in 61 cases. Two patients were discharged with shortening of one-half inch. On later re-examination this shortening had been compensated for.

SUMMARY

1. The frame is simple and easily constructed.

2. Not everyone is equipped to use plaster-of-Paris or make a suitable sized Thomas splint. This frame or even modifications utilizing its basic principles can be used.

3. The motion allowed causes enough irritation to stimulate the formation of callus.

4. Radiography is made easy.

5. With compound fractures this method allows for easy approach to wounds for dressings.

THE COCCYX—ITS DERANGEMENTS AND THEIR TREATMENT

By PHILIP LEWIN, M.D., Chicago

HAVING learned very little clinically about the coccyx in medical school and never having seen a student or interne whose experience was different, the writer is tempted to write this short clinical note. Textbook descriptions are not, as a rule, satisfactory.

The coccyx represents the remains of the anthropoid tail, for which reason it is often referred to as the "tail bone." Its function in man is to afford attachments to muscles. These do not suffer, however, by its removal.

The anatomy of this region is briefly as follows: The coccyx consists of four segments joined together, making a cone-shaped structure which articulates above with the sacrum forming the sacrococcygeal joint. Four important muscles attach to the coccyx, viz.: the gluteus maximus posteriorly, the coccygeus anteriorly, the sphincter ani to the tip in front, and the levator ani to the tip behind. The sacrococcygeal ligaments are found above. The nerve supply of this region is derived from the posterior divisions of the coccygeal, and second, third, fourth, and fifth sacral nerves plus the anterior divisions of the fifth sacral and the coccygeal nerves.

The most important clinical disturbances of the coccyx are "dislocation," ankylosis at the sacrococcygeal articulation, tumors, and disease. The first of these is much more important than the others.

Symptoms of "dislocation" of the coccyx are pain, coccydynia, especially on sitting. Patients complain of inability to sit through a movie show or a theater performance, of pain while riding horseback, etc. They must squirm and twist to be comfortable. The discomfort is usually more marked while the patient is sitting on a soft than on a hard surface because in the latter instance the weight rests on the tuber ischii but in the former case it may be borne in part at least by the coccyx. There may be pain on defæcation, especially if the patient is constipated.

Roentgenograms often reveal no demonstrable pathology, and the surgeon must rely upon the history and physical examination. The history is usually that of a fall and forcibly sitting down or of a blow or kick. It is more frequent in females, many of whom are neurotic. Many patients have tried hot sitz baths and sitting on rubber rings, adhesive strapping of the pelvis, etc., with variable relief.

Rectal examination is very valuable. With the patient lying on the left side with knees and hips flexed, the right index finger is inserted into the rectum and the thumb placed over the coccyx outside that structure. If there is abnormal mobility at the sacrococcygeal articulation and accompanying sensitiveness and tenderness, the diagnosis is made.

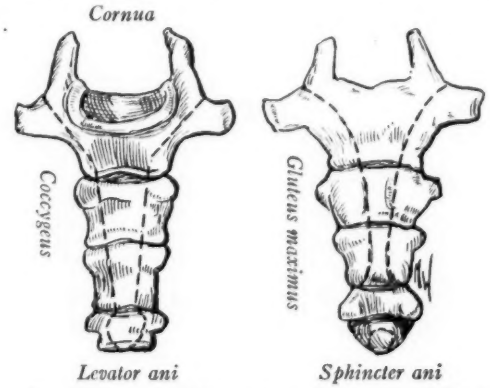


Fig. 1. Coccyx and its muscle attachments. (Modified from Gray's *Anatomy*.)

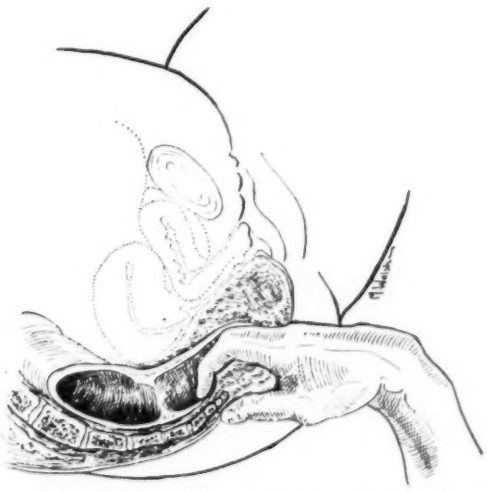


Fig. 2. Patient on left side, knees and hips flexed. Examiner's right index finger in rectum and thumb outside.

The pathological changes are chiefly anatomical but cases of tuberculosis have been reported and tumors, especially teratomata, are found in this region. Many patients with coccydynia have arthritis of the lumbo-sacro-iliac region, and it is important to explain that removal of the coccyx does not cure the arthritis higher up. The operative relief in selected cases should be constant.

The treatment is operative. A midline incision is made in the median raphe. With a finger of an assistant constantly in the rectum, as a guide, a careful dissection is made and the coccyx is removed at the sacrococcygeal joint. Two or three deep sutures and two or three superficial silkworm sutures and a collodion-gauze dressing suffice.

A NEW METHOD FOR SUBPERITONEAL DRAINAGE

By JOSEPH B. BACON, M.D., F.A.C.S., Macomb, Illinois

THE following is a proposed method for improved drainage of the subperitoneal space following the primary operation for removal of carcinoma of the rectum by the Coffey method.

When Coffey published his classic operation for cancer of the rectum, a wonderful advance was made in rectal surgery, and some of our great surgeons expressed the belief that the last word had been written in operative methods for rectal cancer. Experience has taught us, however, that vertical drainage of the subperitoneal space after the primary operation according to the Coffey technique is not perfect, and that it has the same faults that were found in vertical or "up-hill" methods of draining the pelvis in the past, when various forms of tubes and drains were in general use.

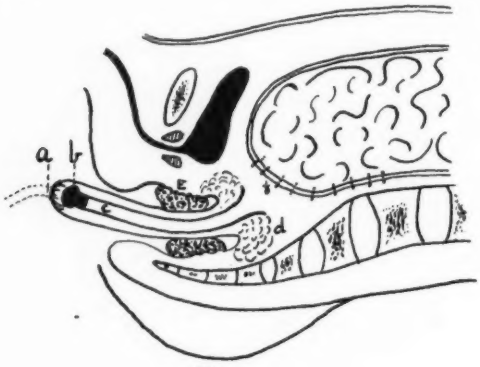


Fig. 1.

Fig. 1. *a*, Closed end of inverted sigmoid with inversion tube; *b*, plug in end of drainage tube; *c*, metal drainage tube; *d*, gauze pack; *e*, rectal carcinoma; *f*, sutured peritoneum.

Why not use the sigmoid when it has been invaginated through the rectum and anus, as an aid in securing drainage from the bottom of the subperitoneal space? Its serous lining is aseptic and can be kept so for from 24 to 48 hours, until the peritoneal suture line has become secure against general infection of the peritoneal cavity. In the meantime, and afterward up to the completion of the second operation, absolutely perfect drainage will be secured.

In order to accomplish this I have had made an aluminum tube 8 inches long and ½ inch in diameter with a flange at the upper extremity 2 inches in diameter and a plug fitting loosely into the distal end having a rounded ball surface which cannot engage and tear the surface of the sigmoid when passed through it. The tube is curved to follow the sacrum and the flange is so broad that the gauze placed in the sacral and bladder spaces can be packed under the flange without interfering with free drainage.

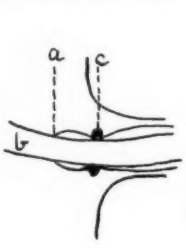


Fig. 2.

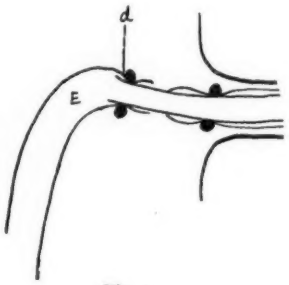


Fig. 3.

Fig. 2. *a*, Cauterized end of sigmoid; *b*, metal tube; *c*, rubber ligature.

Fig. 3. *d*, The rubber ligature; *e*, the rubber drainage tube.

Every detail of the Coffey operation is carried out except that of drainage. When the abdominal wound is closed and its dressing completed, the drainage apparatus is adjusted. First, a rubber band is applied tightly around the sigmoid and metal tube near the anus and the ends tied with a silk or linen ligature. A safe knot cannot be made with rubber. Then with a cautery knife the sigmoid is severed about 1 inch distal to the tight band, and with forceps the distal sigmoid and the ball-plug are removed from the metal drainage tube, which remains aseptic.

A loosely fitting rubber drainage tube is next passed over the end of the metal tube and firmly secured by another rubber band. Thus a clean siphon is obtained from the subperitoneal space into a jar of antiseptic solution at the bedside.

At the time of the second operation, this metal drainage tube can be employed as a handle, and great assistance given in the enucleation of the cancer mass.

One occasionally finds that in cancers of the rectum there is an almost complete constriction, but careful examination will reveal that under complete anæsthesia, the constriction relaxes, and the soft cancer tissue can be crushed with the finger and an opening sufficient for the passage of the tube easily made. Or if necessary the opening may be curetted gently to a diameter sufficiently large for the passage of the drainage tube. This, of course, is permissible only because all blood and lymph channels have been eliminated at this stage of the operative procedure.

SUMMARY

1. The Coffey operation remains the best method of procedure for the removal of rectal cancers.

2. The method of vertical drainage of the subperitoneal space constitutes a serious defect in this operation.

3. A new method of drainage is proposed involving the use of a flanged metal tube extending out through the sigmoid and anus, making an air-tight, aseptic connection with an ordinary bedside drainage apparatus.

REFERENCES

COFFEY, R. C. Ann. Surg., 1922, lxxvi, 500.
Idem. Surg., Gynec. & Obst., 1924, xxxviii, 723.

THE POSTOPERATIVE CARE OF OLLIER–THIERSCH SKIN GRAFTS; ADVISABILITY OF DAILY SURGICAL DRESSINGS

By ELBERT T. RULISON, B.S., M.D., Sacramento, California
From the Sutter Hospital

"SKIN-GRAFTS should not be dressed for from 5 to 8 days unless there is evident suppuration about the grafts" (3).

"The time of the first dressing after the operation will of necessity vary somewhat with one's conception of the degree of infection present. In grafts applied to a sterile fresh surface, the dressing need not be taken down for 5 days at least, but when dealing with a granulation surface we are in the habit of doing the first postoperative dressing on the third day" (1).

This advice accurately reflects the current conception of the immediate after-care of Ollier-Thiersch skin grafts. A careful review of the literature has failed to reveal any reference to daily dressings, beginning twenty-four hours after operation. The advisability of early and frequently repeated dressings rests upon the indisputable fact that in most instances following the application of the grafts we are dealing with an exudative, contaminated wound, and that such a wound requires the utmost surgical cleanliness; the feasibility of the method rests upon the demonstrable fact that the primary dressings may be removed in twenty-four hours or less without disarranging the grafts.

The areas most frequently elected for Ollier-Thiersch grafts are granulating surfaces resulting from deep burns or extensive wounds. Varying numbers of organisms may be recovered from these wounds or from the tissue spaces at the time these surfaces are in "prime" condition for the transplantation of the grafts. The grafts likewise are not free from organisms in all instances, as observation has been repeatedly made that staphylococcus albus is present in the superficial layers of certain supposedly clean epidermis. Inasmuch as abstention from the use of antiseptics is the rule in preparation of these areas from which grafts are taken, the viability of any organisms present is in no way affected. In the case of fresh operative wounds with sterile muscular base the results of skin grafting have always been uniformly excellent. Here we have conditions closely approximating sterility, if not actual sterility. It is in the other instances of large granulating surfaces that failures or partial successes are more frequent. Yet it is possible to have complete success quite uniformly in the latter cases if one but follows the established rules of unremitting surgical cleanliness in the dressing of these contaminated wounds.

The sequence of histological changes occurring in the area of the applied grafts from the time of operation is of interest and importance and further substantiates the contention that these areas may and should be dressed early and often. Briefly these changes are:

1. Formation of fibrin from the plasma present on the surface of the wound and on the under surfaces of the grafts. Expression of serum occurs at the time the fibrin is formed.

2. Period of plasmatic circulation: 24 to 48 hours.

3. Primary anastomosis of vessels from wound to graft or the growth of vessels from the wound into lumina of vessels of the graft. This process is complete in 48 to 72 hours (2).

4. Growth of vessels constituting permanent blood supply into graft: fifth to twelfth days. During this time the tissue spaces are flooded with leucocytes dealing with bacteria and disposing of products of degeneration. Growth of fibroblasts is likewise taking place, binding grafts more and more firmly into place. These changes are virtually those taking place in any healing contaminated wound. The only difference is that as a rule the contaminated wound presents a breach in continuity of tissue with forces of repair advancing from either side, while the skin graft must depend upon the forces of healing advancing from but one side.

The method of postoperative care to be described takes cognizance of these several changes. At the time of transplantation it may be observed that within a period of 5 to 10 minutes the graft becomes lightly anchored to the wound surface. It will withstand considerable lateral pressure without moving. This is due to the formation of fibrin, the wound cement which is to function also as a matrix, permitting the so-called plasmatic or lymph circulation and supporting budding endothelial cells of the newly forming blood vessels destined to nourish the graft. The grafts are placed so that there is a margin of 1 to 2 millimeters between them for the escape of serum and the leucocytic exudate which will certainly form. This detail is at variance with the advice

usually given to overlap the grafts. The overlapping of the grafts was devised to prevent their disarrangement and hasten eventual healing but does not take into consideration proper drainage which is so essential in a contaminated wound. These narrow uncovered margins rapidly epidermatize and the matter of maintaining the grafts in place may be dealt with by means of efficient wound splinting.

Freshly grafted areas call for the application of a smooth, non-cohesive material. Strips of thin gutta-percha tissue or plain cellosilk serve the purpose admirably. This material should be sterilized by scrubbing with soap and water, soaking for 2 hours in 1 to 4,000 solution of bichloride of mercury and should then be thoroughly rinsed in sterile water and placed in 4 per cent boric solution. Strips roughly 1 to 1.5 centimeters in width are applied criss-cross, leaving narrow spaces between the strips for escape of exudate. The strips should be long enough to extend 2 or 3 inches beyond the wound margins. In this way the grafts are splinted and securely anchored in position.

The next point of importance is the application of a highly absorbent, mildly antiseptic gauze dressing. A moist boric dressing of sterile used-gauze of four thicknesses made up in rolls of 5 yards, and 6 to 8 inches in width is applied in a circular or spica fashion. Appropriate splinting with molded fiber board may also be incorporated.

The first dressing subsequent to the operation should be at the end of not more than 24 hours. The fear of disturbing or loosening the grafts probably has deterred surgeons from exposing the wound at this time. Gentleness must necessarily be observed in removing the strips of tissue, although no unusual skill is required. The strips are removed either individually or collectively. Here and there adhesions may be present, which necessitate counter pressure on the graft as the strips are lifted. At this first dressing the grafts appear dead white since there is as yet little or no circulating blood in them. The test of capillary circulation is not present. At this time the graft is being held by the matrix of fibrin and is being nourished by a plasmatic lymph circulation. Endothelial cells of the capillary tufts of the granulation tissue are budding out to form anastomoses with the vessels of the graft, but definite vascularization has not yet been established. The wound exudate present on the dressings is considerable and smears of the exudate from wounds covered by granulation surfaces show organisms as a rule. The surface of the grafted area may be lightly sponged with tufts of Grade A absorbent cotton wrung out in boric solution and fresh strips of cellosilk and gauze rolls applied as at the primary dressing.

At the end of 48 hours the grafts show a decided change in appearance. They now present a pinkish hue and respond to the test of capillary circulation. J. Staige Davis and Herbert F. Traut in a series of experiments with dogs have observed vascularity as early as 22 hours in whole thickness grafts. These primary anastomoses are usually complete in 48 to 72 hours. We may therefore state as a fact that union has occurred, that the graft has actually "taken" when the test of capillary circulation is positive. Clinically this will be found to correspond exactly with the findings in Davis's and Traut's experimental animals. Their statement is as follows:

"We conclude that there are two stages in the process of actual vascularization of the graft. These have been preceded by what has been called the stage of plasmatic circulation, which probably bears an important rôle in the survival of the whole thickness of the graft. The first stage of vascularization is supplied by those vessels which form early anastomoses with small vessels of approximately the same caliber in graft and host. The earliest that this was noted was about 22 hours after transplantation, and this continued to occur up to about 72 hours. The second stage and the most important one, as it establishes a more voluminous blood supply which eventually forms the permanent vessels of the graft, begins on the fourth or fifth day and has completely penetrated the graft by the twelfth day. At this time, the various elements of the graft are actively regenerating; especially is this true of the connective tissue of the corium, which is richly supplied with new blood-vessels."

At the succeeding daily dressings it may be noted that here and there a bleb may form, partially raising the graft from its bed. These blebs should be punctured, thereby saving many grafts which would be sacrificed were the initial dressing postponed for the customary period of 5 to 8 days.

As early as the fourth and fifth days, dressings may be discontinued and the area exposed. During the first day of exposure the grafts should be watched carefully as the vents for the escape of wound exudate may close off too rapidly and blebs form which would tend to detach the grafts here and there. Puncturing the blebs may be practiced, or application of moist dressings may be resumed and continued until the period of degenerative and inflammatory changes has terminated. These degenerative changes, together

with a varying degree of inflammation due to the reaction of the tissues to the presence of micro-organisms, account for the continuance of wound exudate during this period (4).

One may expect the average case to be entirely epidermatized in 7 to 10 days under this method of postoperative care.

The objection frequently raised to the use of Ollier-Thiersch grafts on areas where shrinkage would be an untoward factor may be met in some degree by urging the profession to bring areas requiring grafts to the "prime" condition rapidly and to transplant before the fibroblasts are consolidating into scar tissue. Following the detachment of the sloughing tissues of third degree burns or extensive wounds, a wet dressing of ½ per cent zinc sulphate solution in most instances will promptly transform the surface to one of fine, coral-red granulations. The high degree of vascularity of the granulations will be attested by the ease with which bleeding occurs when they are sponged with gauze. If grafting be done promptly, the degree of shrinkage that follows will be greatly diminished.

No reference has been made to the technique of cutting and placing Ollier-Thiersch grafts as the details of transplantation are so well standardized that they may be omitted.

SUMMARY

Daily dressings of Ollier-Thiersch skin grafts are advisable inasmuch as the wound in most instances is an exudative, contaminated one which may readily pass to a state of infection with consequent sacrifice of transplants. Scrupulous surgical cleanliness with early and frequent removal of wound exudate alone may be expected to give uniformly excellent results. A rational method of procedure is described which tends to maintain grafts in position. The method is in accord with the sequence of histological changes and results in earlier complete epithelization.

REFERENCES

1. Colles, Frederick A. The use of paraffin as a primary dressing for skin grafts. Surg., Gynec. & Obst., 1925, xli, 221.
2. Davis, John Staige, and Traut, Herbert F. Origin and development of the blood supply of whole-thickness skin grafts. Ann. Surg., 1925, lxxxii, 871.
3. Kanavel, Allen B., and Koch, Sumner L. Preoperative and postoperative care of the patient. Surg. Clin. North Am., 1926, vi, August.
4. Smith, Ferris. A rational management of skin grafts. Surg., Gynec. & Obst., 1926, xlii, 556.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D. . . . . Managing Editor
ALLEN B. KANAVEL, M.D. . . . . Associate Editor

WILLIAM J. MAYO, M.D. . . . . Chief of Editorial Staff

NOVEMBER, 1927

NURSE VERSUS DOCTOR

THE standing of the medical profession has been won by many years of strenuous endeavor. The actuality and scientific basis of our achievements distinguish us from the various cults; and our knowledge and experience place us upon a higher level than the trained nurse, however admirable in her own field a nurse may be.

It goes without saying that this hard-won prestige should be guarded with jealous care, not only for ourselves but for those who are to follow us. In order to accomplish this it manifestly is our duty to see that the dignity and authority of the younger members of our profession are encouraged and guarded as far as lies within our power, especially in the institutions over which we have jurisdiction. And yet, in spite of this obligation, there is a growing tendency in some hospitals, fortunately not in all, to exalt the nurse at the expense of the interne.

Some staff officers, for instance, seem inclined to deal directly with the nurse in the handling of their cases, rather than with the interne; thus depriving the latter of that responsibility and authority which is so necessary to his professional development. I even know of a hospital in which this degradation of the internes was carried so far that their authority was practically annulled, a situation which, properly enough, led to such a taboo of the institution by younger physicians that internes could not be obtained.

In some instances, as I have seen, this recent tendency toward the aggrandizement of nursing seemingly has led to the assumption of an unwarranted independence of this department from the medical organization of the hospital; in spite of the fact that nursing, however important it may be, is nevertheless subordinate to treatment, and always should be carried on under the supervision of the medical staff, which should be consulted upon all important matters.

One of the worst offenses along this line has appeared in the establishment in certain hospitals of so-called "treatment-centers," where surgical and other supplies are concentrated in the charge of graduate nurses and dealt out to the various rooms and wards as required. This perhaps is not a bad idea when confined to its legitimate function, the furnishing of supplies; but unfortunately in some instances it has gone far beyond this, and to the nurses of these centers has been delegated the changing of dressings, the giving of hypodermoclysis, and many other duties which properly belong to the internes, or, under their directions, to the floor nurses. This not only comes dangerously near to making doctors out of nurses, but it deprives the house physicians and floor nurses of their rightful prerogatives, and gets them out of that close touch with their patients which is so necessary to their

proper instruction and to the intelligent handling of their cases. In other words, it leads, all along the line, to a wholesale "passing of the buck" back to the treatment center, and everyone loses out accordingly. After all, there is something in a name, and the situation would perhaps be remedied by changing the term "treatment center" to "supply center" which indicates more accurately what it really should be.

The trained nurse is an indispensable asset, deserving of our greatest respect and appreciation; but it should be understood that after all she is a nurse and not a doctor. Her subordinate position in this respect should be clearly defined, and any tendency which may quite naturally develop to cross the boundary should promptly and courteously be discouraged, in her own interest as well as that of the medical profession and the patient.

LEONARD FREEMAN.

DIRECT MICROSCOPIC EXAMINATION OF FISTULÆ

ONE of the disappointing results of surgical operations is the formation of a draining sinus or fistula. Although it is true that in certain operations this is a desirable result, in the majority of cases it is an indication of unsatisfactory surgical procedure or the presence of some disease that does not permit the healing of tissues. The diagnosis of such a pathological condition is often difficult, due to the fact that cultures made from these sinuses are usually a waste of time since so many secondary organisms are present that the original causative organism is masked. It is in such cases that direct microscopic examination of scrapings from the tract is of greatest importance.

The inclusion of a foreign body may often be determined by lightly curetting the tract with a wire curette. The curette consists of a piece of 22-gauge nicrome wire rounded into a loop 3 millimeters in diameter; the other end of the wire is inserted into a suitable handle. The flexibility of the wire prevents injury and accidents. Occasionally parts of a sponge may be withdrawn through the tract or hard objects such as bone sequestra or surgical instruments may be encountered. On one occasion, a large mass of hardened bismuth paste was detected over the region of the kidney and its removal by surgical intervention resulted in the healing of a sinus tract of about 3 years' duration following nephrectomy.

Even teratomata have been diagnosed by this method. By the removal of long tufts of hair by the curette through a sinus tract in the sacral region, teratoma was accurately diagnosed in the case of a middle-aged man.

The diagnosis of tuberculous tracts and tuberculous ulcers by the direct microscopic method is of extreme va'ue. Records in the Mayo Clinic have disclosed the fact that many tuberculous sinuses in the chest and abdomen have been diagnosed in this manner.

Also, sinuses in the scrotum, various joints, and in the neck resulting from the breaking down of tuberculous lymph nodes have been diagnosed tuberculous. Tuberculous lesions in the ear, larynx, and pharynx have been accurately diagnosed by this method. Two cases of tuberculous peritonitis have been diagnosed from scrapings of sinus tracts draining from the umbilicus, and one case of tuberculosis of the breast was diagnosed from scrapings taken from a sinus draining from the left breast. The tuberculous sinus tract is characterized by rather prominent pouting lips, the area about the sinus is dusky purple, and the patient usually shows loss of weight as contrasted with the patient having actinomycotic sinuses, when the weight is

usually normal or increased. The sinus should be curetted until bleeding occurs; this is easy in tuberculous tracts since they are vascular as contrasted with sinuses due to actinomyces.

The diagnosis of actinomycosis (actinomyces hominis) is practically dependent on the finding of sulphur bodies in the drainage material. About 200 cases have been so diagnosed in the Mayo Clinic. These represent lesions of the head, neck, abdomen, and chest. The lesion is fairly characteristic. The sinuses are often multiple and the history usually extends over several months or even years. As a rule there is little granulation tissue around the mouths of the sinus and discoloration is not a prominent characteristic. Such sinuses usually appear as simple holes in the flesh, and if a scab is present it is very thin and bloody. The tract does not bleed much when it is curetted and the typical sulphur bodies usually come out on the loop of the curette. The drainage material is usually thin. Often the sulphur bodies are obtained from a deep part of the sinus when none are evident in the draining pus. The abdominal sinuses are in and around the appendiceal region and the patient's history is rather stereotyped. He was operated on for acute appendicitis several months or even years before. At the time of the operation drains were probably inserted because the appendix had ruptured; the wound had not healed, or if it had, it had broken down periodically. On examination one or more sinuses are found and often these have penetrated through the body, and sinuses are found in the sacral region. A definite clue is furnished by the fact that, with the marked development of sinuses, bone is rarely if ever involved, thereby differing from tuberculosis.

The diagnosis of other mycotic lesions and sinus tracts developing from the involvement of bone due to typhoid bacilli is an exception to the rule that the diagnosis must be made on direct microscopic examination. In these cases cultures are necessary and by suitable cultures the presence of acid-fast actinomyces, which have in the past been called nocardia, or streptothrix and typhoid bacilli is detected. Occasionally cancer cells are found in the scrapings from sinuses. The nasal scrapings are of tremendous importance in the diagnosis of leprosy.

A plea is made for more careful direct microscopic examination of chronic draining sinuses and fistulas; such examination will amply repay the diagnostician for his efforts.

T. B. Magath.

MASTER SURGEONS OF AMERICA

SAMUEL JASON MIXTER

THE passing years add to the list of the illustrious dead. We who are living pay homage to the great men of the past who made meritorious contributions to the progress of the world and who to the last carried on by example or precept in order to leave undone nothing that might help the causes they so nobly espoused. To such Samuel J. Mixter belonged.

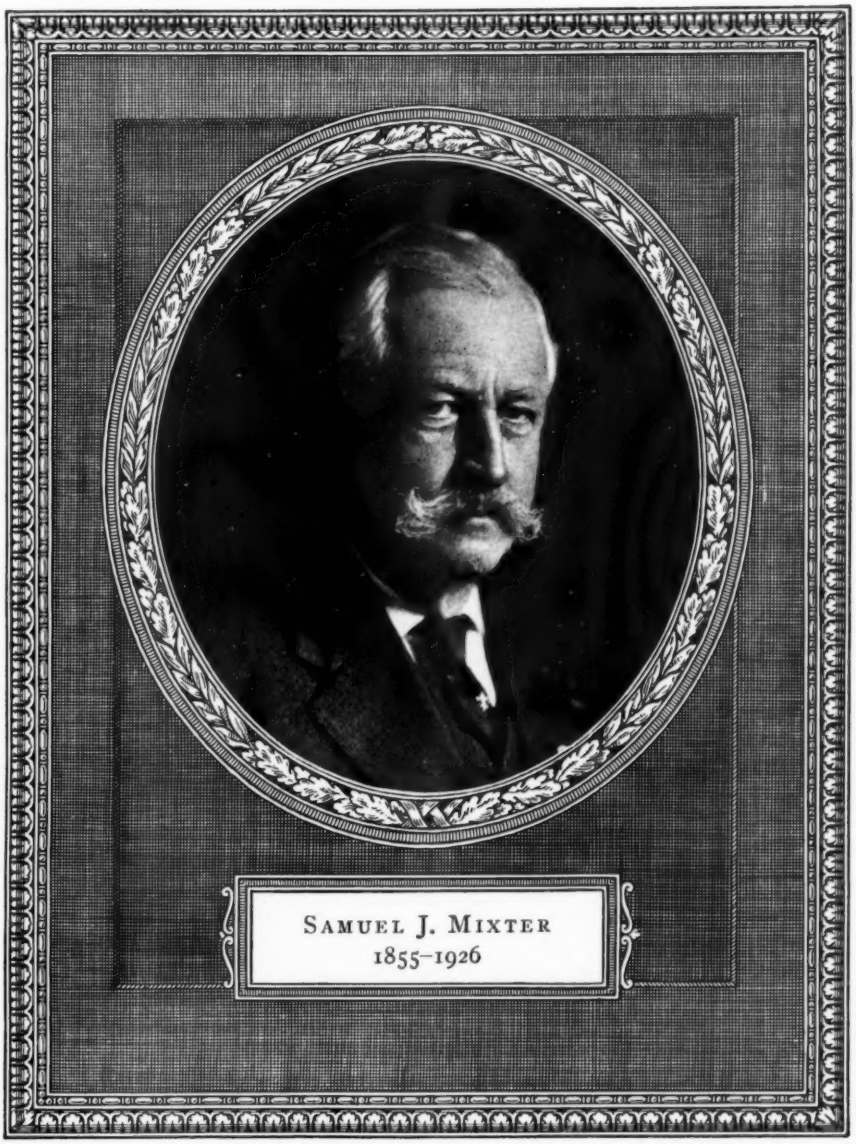
It is nearly thirty years since I first went to Boston to visit clinics and to learn from the Fellows of the splendid Boston school of surgery, always sane, sound, and solid, free from illusions or extreme views, in verity, the truth-tellers. As I went into the reception room of the old Massachusetts General Hospital to learn what would be presented at that day's clinics, there came with buoyant step and pleasant smile, Samuel J. Mixter. He recognized at once that I was a diffident young man from the West, and kindly asked what he could do. He took me under his wing, introduced me to the staff of the hospital and into the various operating rooms, and made me feel at home. In the many years that have passed since that day I have never failed to appreciate his warm interest, not only in surgery but in the surgeon as an individual as well.

This personal tribute to Dr. Mixter I make as an introduction to the memorial written by two of his colleagues and adopted by the Boston Surgical Society.

W. J. MAYO.

Samuel Jason Mixter was born in Hardwick, Massachusetts, on the tenth of May, 1855. His father, William Mixter, and his mother, Mary Ruggles Mixter, were both of old New England stock. He died after a brief illness of pneumonia at Grand Junction, Tennessee, on January 19, 1926.

His boyhood was chiefly spent at Hardwick and at school in Amherst, Massachusetts. He entered the Massachusetts Institute of Technology, where his natural tastes led him to specialize in physics, and later, after graduation, to undertake the study of medicine, a course in which he received little parental encouragement. He graduated from the Harvard Medical School in 1879, completing his course as West Surgical House Officer at the Massachusetts General Hospital in the same year. In 1879 as well, on August 12, came the fortunate event of his life, his marriage to Wilhelmina Galloupe.



SAMUEL J. MIXTER
1855–1926

This was followed by a year in Vienna, where his interest was keenly stimulated in anatomical studies and by the developing microscopic pathology. On his return to Boston, his work in microscopy and anatomy was continued. In 1882 he became assistant demonstrator and in 1887 demonstrator of anatomy at the Harvard Medical School. His enthusiasm was infectious to students and drove him to continuous activity, to the painstaking care and thoroughness of which his beautiful corrosion specimens in the Warren Museum still bear witness. His teaching later swung to operative surgery, a field which gave further scope to his great mechanical ingenuity.

Thus, from the first, his tastes and training led him to surgery, where his ability and special aptitude resulted in rapid progress. Appointed to the Surgical Service of the Carney Hospital in 1880, and Surgeon to the Out Patient Department of the Massachusetts General Hospital in 1886, he became successively surgeon to the Carney Hospital, resigning in 1897, visiting surgeon to the Massachusetts General Hospital in 1893, chief of the West Surgical Service in 1911, resigning at the age of sixty-four in 1919.

From his background and the character of his training, some inklings as to the nature of his surgery may be derived. Brought up on a sound anatomical foundation before the era of specialization, in the beginning of antisepsis, when the shadow of infection threatened, his training had a breadth and a respect for surgical dangers now vanishing. To this he added great mechanical ingenuity and a keen, conservative judgment. His operating was marked by simplicity and directness, qualities which can only come from thorough anatomical knowledge, great skill, and a keen appreciation of essentials. His sense of mechanical fitness made him dislike cumbersome instruments and technique. Intellectual honesty caused him to be impatient of shams and pretenses, and of an unbalanced interest in percentage figures of operative mortality. Sound judgment, sure and rapid operating, complete lack of mercenary traits, entire self-forgetfulness in the interest of his patients, were qualities which begat confidence in the minds of practitioners and laity alike.

In surgery his resourcefulness and ability to cope with the difficult and unusual attracted him to neglected fields. From this came his contribution to the surgery of the œsophagus and of the central nervous system, advances which stand out among others he added to the rapidly developing science of surgery. His contributions to operative technique, unfortunately, will be known chiefly by tradition; in the fertility of his invention they seemed to him hardly worthy of record. It is only natural and fitting, therefore, that he should have been chosen president of the American Surgical Association in 1917, and that the New England Surgical Society should have turned to him for its first president.

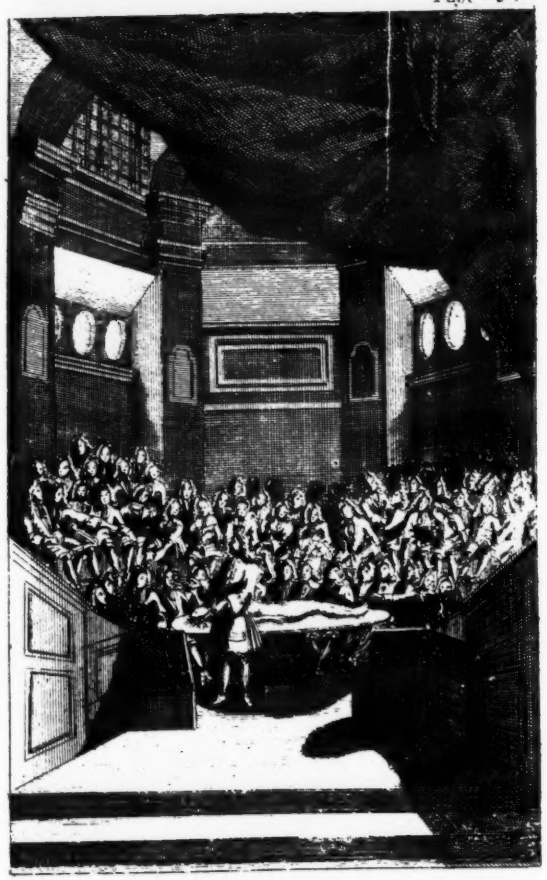
Success in a profession is in itself an accomplishment which the world stands ready to honor. Dr. Samuel Jason Mixter's eminence in surgery needs no com-

ment or support; it is a fact grown so familiar that we can as yet be scarcely conscious of the gap left by his death. But although accomplishment in surgery should be duly honored, it is not for that reason alone that we delight in the memory of Dr. Mixter. We are led rather to think of the personality and character that lay behind it. To his numerous friends he seemed the personification of kindly hospitality, so open-hearted and genuine that it spread an irresistible warmth. It is pleasant to remember the true cordiality with which he was received at meetings of the American Surgical and Southern Surgical Associations. Some of us may think of the generous sportsman, forgetful of his own sport in the interest of sharing it with others, or of mornings during fishing trips spent actually holding impromptu clinics for the families of guides and natives, to be followed by minor operating on teeth and tonsils. Generosity, loyalty, affection, and interest in others, stood out in all his dealings. These same qualities shone most clearly during the War, and his sentiments of patriotism and of indignation against wrong were strikingly expressed in his presidential address before the American Surgical Association. One of the first men to join the Medical Reserve Corps at the time of its organization, he hastened to undertake active duty.

Through all this active and useful life there runs the support of an harmonious family relationship. In later years after retirement from active practice, it was natural that his interest should have turned increasingly to the scenes of his childhood in Hardwick, to his magnificent herd of Guernsey cattle there, and to the outdoor sports he so much loved. It seemed a fitting and peaceful conclusion to a full life. But the death of Mrs. Mixter left a void which his cheerfulness could not conceal.

To have contributed actively to surgery, to have held rightly the confidence of patient and of physician, to have stimulated warm friendship, to have served his country well, and to leave worthy successors, is it not enough?

G. W. W. Brewster.
E. P. Richardson.



A

COURSE

OF

Chirurgical Operations,

Demonſtrated in the

ROYAL GARDEN

AT

PARIS.

By Monſieur *DIONIS*, Chief Chirurgeon to the late DAUPHINESS, and to the preſent Dutcheſs of BURGUNDY.

Tranſlated from the Paris *Edition.*

LONDON:

Printed for *Jacob Tonſon*, within *Gray's-Inn* Gate next *Gray's-Inn* Lane. 1710.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D., F.A.C.S., Omaha

THE COURSE IN OPERATIVE SURGERY
By PIERRE DIONIS

WITH the passing of the French surgeons of the latter part of the sixteenth and early part of the seventeenth centuries, particularly Paré, Jacques Guillemeau, and Franco, surgery in France retrograded, as it did in great measure in other countries. Men like Galileo, Sir Isaac Newton, René Descartes, Pascal, and Francis Bacon held the center of the scientific stage and offered such competition that surgery was not able, with the materials then at its command, to obtain much public attention. In medical science Borelli and the great William Harvey gave their attention to internal medicine and brought forward that side of the medical art so prominently that their followers in France saw their opportunity and promptly took advantage of it. The medical faculty won a victory over the surgeons and obtained a royal decree which united the barbers and surgeons in one corporation. In consequence, the Collège de St. Côme, which had worked constantly for the better education of surgeons, lost much of its power. All of these factors made for the temporary innocuous desuetude into which seventeenth century surgery passed.

In the middle of the seventeenth century, Pierre Dionis was born and by its third quarter was well on the way toward bringing surgery back into prominence, for he began to teach in 1673. In the introduction of his book he says: "The King, better informed than any in his Dominions, of whatever can contribute to the good of his subjects, by a particular Declaration which he caused to be verified and registered in his Presence in March, 1673, ordered that the Demonstrations of Anatomy and Chirurgical Operations should be annually held in his Royal Garden, gratis, and with the doors open, in order to furnish young students in Chirurgery with the means of perfecting themselves in their art, which his Majesty has always looked on as one of the most necessary in a State." This declaration proved to be of immense importance to surgery, for it marked the beginning of true surgical teaching in France and the starting point of the great French school of surgeons who led the surgery of the world for more than a century. Dionis thus had his permission to teach and began to demonstrate anatomy at the Jardin du Roy. At approximately the same time other public demonstrations were begun at the Medicinal School and at the Collège de St. Côme. All of these demonstrations were performed by sworn master surgeons, the others, presumably, being Georges Marechal, surgeon of the Charité and first surgeon of Louis XIV, and Jean Mery, first surgeon of the Hôtel Dieu.

Dionis held that the most important subject for a surgeon to have in hand was anatomy. Consequently, the first course was anatomical demonstration on the cadaver. This, a student had to take before he could begin surgery. Dionis published his Anatomy, *L'Anatomie de l'homme*, in 1690 at Paris, seventeen years before his *Course of Operations*. It immediately became one of the most popular medical books of the time and was translated into many other languages, even into Chinese.

The surgical course became so popular that the original provisions of the "Declaration" had to be changed and the course limited, for he says: "For the space of eight years I have performed those in the Royal Garden to which the Concourse of Students was so great, that the largest Hall destined for them would not hold one half of the Auditors; which obliged us to prepare Sealed Tickets which we distributed to Chirurgeons Apprentices, that they alone might enter, and to avoid confusion by the exclusion of those who were plac'd to serve their time in Barbers Shops, and of those whose bare Curiosity drew them thither."

If Dionis' teaching ability was equal to his interest as a writer, this statement is not overdrawn for his *Cours d'operations de Chirurgie*, first published at Paris in 1707, is a delightful book even in the English translation of 1710, illustrated here, in which some of the charm of the original is of necessity lost, as in all translations. Dionis does not confine himself entirely to surgery, for he indulges also in anecdote and history. He tells more clearly than any other author, the story of the great Frère Jacques, a contemporary traveling surgeon of no education, but a man who commanded a very large clientele. The operations themselves are described in a systematic manner; an illustration of the instruments and apparatus used is followed by a minute description of the operative technique; and in some cases, that of hernia, for example, there is a preliminary discussion of the various types of operation performed up to the author's time which is most valuable for the student of the various surgical procedures.

REVIEWS OF NEW BOOKS

A SMALL monograph[1] dealing with modern operative measures for the cure of inguinal hernia and related features of the anatomy and physiology of the abdominal walls has recently been published. In the introduction by Sir Arthur Keith his well-known views on the shutter-like action of the muscles and tendons of the inguinal region are stated.

In the operation which is described, use is made both of the principles of a purely fascial closure and of autoplastic suture material. Cowell's operation is an ingenious attempt to make use of the principles expounded by Keith and to provide a wall to the inguinal region which will contract when the other abdominal muscles are under tension. Much stress is laid on the "grip" or squeezing of the finger inserted into the inguinal canal when the subject strains. This is said to be well-marked in normal individuals and absent in sufferers from hernia and the operation is said to restore this "grip."

In order to insure its complete removal, the sac is dissected unusually high into the abdomen and cut off; and the edges closed with a running suture. The closure he advocates consists in freeing a strip a half inch wide from the external oblique aponeurosis and sewing it into the floor of the inguinal canal under the cord. The lower edge of this pedicled flap is sutured to Poupart's ligament and the upper edge to "whatever tendinous or fascial structures lie convenient along the inner border of the conjoined tendon." It is evidently hoped that this strip will be pulled tightly against the internal ring when the abdominal muscles contract in response to intra-abdominal tension.

Unfortunately photographs are used to illustrate the operation which are so poor that nothing can be learned from them. The remainder of the 72 illustrations are also of very low grade.

While time alone can decide the value of Cowell's operation, it looks like a promising step in advance and the book is of great value in being a good review of the newest work on hernia and helping to call attention to the wretchedness of our operative results. It should bring to the attention of surgeons the fact that the last word has not been said on hernia.

EDMUND ANDREWS.

DILLER[2] rightly says in his preface that the history of medicine in Western Pennsylvania is closely bound up with the history of the country. In the early days there was an intimate relationship between medical and military life. The first surgeon-soldier in Diller's fascinating narrative is Dr. James Craik, who accompanied General Braddock on his disastrous expedition to the Pittsburgh region in 1754 and who later became Washington's private physician. Then came Hugh Mercer, medical graduate from Aberdeen, long a pioneer doctor in the then wilderness of Pennsylvania, who became a brigadier-general in the American army during the revolutionary war and died of wounds sustained at the battle of Princeton. Among other interesting medicomilitary characters of those days were John Connolly, Edward Hand, and William Irvine. Another interesting group was made up of preacher-physicians, typified by Joseph Doddridge who fortunately left a book of notes to posterity. However, the first place of distinction in the medical annals of Pittsburgh is accorded to surgeon Albert G. Walter, born and educated in Germany, and Diller's fine chapter on this man should particularly interest surgical readers. Aside from its medical interest this book gives a vivid picture of a picturesque period of American frontier history. The style is the best, as are paper, print, and illustrations.

PETER BASSOE.

J. RENFREW WHITE[3] presents a textbook of surgical handicraft for medical students. In the opening chapters on asepsis and antisepsis are brief but interesting biographical sketches on Semmelweis, Pasteur, Lister, Holmes, and others identified with this period. The chapters on antiseptics and surgical materials cover completely the action, use, and formula of various antiseptics as well as the preparation of suture materials and operating room sterilization. Subsequent chapters are devoted to bandaging, adhesive plaster strapping, and the technique of knots, ligatures, and special sutures.

The last portion of the book is devoted to preoperative preparation, principles of operative technique, postoperative treatment, the control of hæmorrhage, and various minor surgical procedures.

This text offers to the student and interne many important practical details of handicraft, which, through lack of time he cannot adequately get in our present medical curriculum.

J. R. BUCHBINDER.

WHILE much has been written of tropical medicine, Major Chatterji's valuable book[4] is probably the only work of any consequence devoted to tropical surgery. The author's more than 25 years' experience in Calcutta and other places in India has well fitted him for the authorship of a work

[1] HERNIA AND HERNIOPLASTY. By Ernest M. Cowell, D.S.O., M.D., B.S. (Lond.), F.R.C.S. (Eng.). With an Introduction by Sir Arthur Keith, F.R.C.S., F.R.S. New York: Paul B. Hoeber, 1927.

[2] PIONEER MEDICINE IN WESTERN PENNSYLVANIA. By Theodore Diller, M.D. With a foreword by J. J. Buchanan, M.D. New York: Paul B. Hoeber, 1927.

[3] A TEXTBOOK OF SURGICAL HANDICRAFT FOR THE USE OF MEDICAL STUDENTS. 2d ed. By J. Renfrew White, Ch.M. (N.Z.), F.R.C.S. (Eng.), F.A.C.S. New York: The Macmillan Company, 1926.

[4] TROPICAL SURGERY AND SURGICAL PATHOLOGY. By Karuna V. Chatterji, F.R.C.S.I., Major I.T.F. Medical Corps. With a foreword by Major-General Sir R. Havelock Charles, G.C.V.O., K.C.S.I., M.D., LL.D., M.Ch., F.R.C.S.I., I.M.S. (Ret.). New York: William Wood & Company, 1927.

which is not only indispensable to those who are about to practice tropical surgery and who are unfamiliar with it, but also has great interest and profit to surgeons in non-tropical countries. The writer discusses the peculiarities of tropical surgery as distinguished from that of colder climates, the subject of amœbiasis with all phases of hepatic amœbiasis, and filariasis and the numerous surgical complications arising from this infection. The details of the surgical treatment of elephantiasis of the scrotum are carefully taken up.

The section on tropical granulomata describes the pathology, diagnosis, and treament of some 23 varieties. Other sections take up schistosomiasis, ascariasis, and bone and joint surgery, including pesgigas and ainhum. The section on abdominal surgery is brief. Interesting chapters on snake-bite and injection of saline solution in cholera are included. The book is a valuable contribution to surgical literature. FREDERICK CHRISTOPHER.

THE second edition of Kneise's *Atlas of Cystoscopy*[1] is a much larger work than was the original edition, the many new illustrations adding value and increasing its worth as an adjunct to the better understanding of cystoscopy. On account of the number and variety of illustrations the author rightly does not deem it necessary to discuss the development of cystoscopy or give details as to instrumental asepsis, technique of endovesical operations, kidney function tests, etc. In any atlas these discussions are matters of less importance than the illustrations and in the case of the atlas under discussion, by reason of its many illuminating illustrations, discussions wandering off into details would surely detract from its worth and value as an atlas in the best sense of the term.

The arrangement of the book is exceedingly satisfactory. It consists of three parts: a brief introduction to the subject; the atlas proper represented by a section of 102 colored illustrations; and a series of clinical histories.

The colored illustrations begin with plates showing the normal bladder and variations in the normal bladder and ureteral openings, followed by inflammatory changes seen in the common and rare forms of cystitis. The various cystoscopic changes associated with benign hypertrophy of the prostate are given careful consideration. With unusual truthfulness are illustrated a series of bladders, the various types of stones, different types of foreign bodies in the bladder, benign and malignant tumors, and the various intravesical methods of treatment such as the cystoscopic snare and fulguration. Bladder fistulæ, diverticula, and ureteroceles are illustrated in a manner that leaves nothing to be desired, and again truth is not maimed in the making of artistic illustrations.

The section of the atlas devoted to clinical histories will be found of great help to the reader, if for no other reason than that by means of these histories a better understanding of the illustrations is achieved.

All in all this atlas is one that should be highly commended; it has been prepared with care and in no instance has the scientific spirit been sacrificed.

HERMAN L. KRETSCHMER.

IN his monograph[2] on prostatic surgery, Dr. Walker brings up to date the knowledge upon this subject. It might well be read by specialists. In contrast to many European compilations, the work follows the generally accepted ideas of American urologists, the author having familiarized himself thoroughly with recent advances in this subject both in America and abroad. The subject matter is presented in a simple easy reading fashion with the greatest stress laid upon practical considerations. The anatomy and physiology of the prostate and contiguous structures and the pathology of enlargement constitute the preliminary chapters. Symptoms, diagnosis and treatment, with emphasis as to the importance of pre-operative and postoperative treatment, are given in detail.

VINCENT J. O'CONOR.

A COMPREHENSIVE monograph[3] by Foerster on the sensory pathways for pain and the surgical treatment of painful conditions illustrates very well one of the statements the author makes in the introduction, that although neurology has given much to surgery, surgery has caused neurology to revise many dogmatic theories. The monograph is divided into two parts.

The first deals with the physiology of the sensation of pain. In this section the author presents in a clear and comprehensive manner the recent thoughts concerning pain. The isolated supply of peripheral nerves is described, stressing the areas of overlap; visceral sensibility is then reviewed. There follows an important description of personal observations upon root distribution of sensory fibers. The failure of posterior root section to relieve painful states has given rise to experimental work upon the possibility of pathways other than the posterior roots, and the author describes the conception of an antidromic fiber in the anterior root which he, with others, described in 1920, after the work of Leonard Kidd. The question of the possible sensory function of the sympathetic system and an extraradicular pathway is discussed. Of great importance are the numerous observations permitting a description of the lamellar distribution of sensory fibers within the spinal cord and brain stem. Thalamic pain and cortical sensory localization is described.

The second part covers affections of the peripheral nerves and their treatment, including neurolysis, nerve block, root section, periarterial sympathectomy, amputation neuromata, cervical ribs, neuritis,

[1] HANDATLAS DER CYSTOSCOPIE. By Dr. med. Otto Kneise. Leipzig: Georg Thieme, 1926.

[2] THE ENLARGED PROSTATE. By Kenneth M. Walker, F.R.C.S., M.A., M.B., B.C. New York: Oxford University Press, 1926.

[3] DIE LEITUNGSBAHNEN DES SCHMERZGEFUEHLS UND DIE CHIRURGISCHE BEHANDLUNG DER SCHMERZZUSTAENDE. By Prof. Dr. O. Foerster. Berlin: Urban & Schwarzenberg, 1927.

and neuralgia; affections of the cranial nerves, with the glossopharyngeal, vagus, and intermedius neuralgias; visceral nerve surgery, angina pectoris, intermittent claudication, and thrombo-angiitis obliterans; and diseases of the spinal ganglion and roots, cord tumors, tabes dorsalis, and other diseases of the cord and brain stem. Finally a description of an interesting group of headaches in given which revives the embalmed conception of disproportion between the size of the brain and the cranial cavity.

LEWIS J. POLLOCK.

AN article on the paralyses of peripheral nerves which appeared some time ago in the Kraus-Brugsch System of Special Pathology and Therapy has been enlarged and rewritten from impressions obtained from the material of the late war. The book[1] as it now appears is a comprehensive description of methods of diagnosis, of symptomatology, and treatment, and is well suited to students inasmuch as considerable space is devoted to differentiation.

The chapter upon surface markings of muscles is excellent. That upon electrical examination is limited to older methods. In the discussion of reflexes much space is devoted to a description of reflexes which are little disturbed in peripheral nerve lesions. Considerable attention is paid to physiotherapy, but the various surgical procedures in the repair of injuries are only briefly mentioned.

In the consideration of injuries and disease of special nerves, the description of the anatomy and physiology is comprehensive and clear. The liberal quotation of the opinions of other authors makes the material profitable and interesting.

LEWIS J. POLLOCK.

[1] DIE PERIPHERISCHEN LAEHMUNGEN; DIAGNOSTIK, UNTERSUCHUNGSTECHNIK, PROGNOSTIK UND THERAPIE. By Prof. Dr. Toby Cohn. Berlin: Urban & Schwarzenberg, 1927.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

NORMAL MIDWIFERY FOR MIDWIVES AND NURSES. By G. W. Theobald, B.A., M.D., B.Chir.(Camb.). F.R.C.S. (Ed.), M.R.C.P.(Lond.), L.M.(Rot.). New York: Oxford University Press, 1927.

THE THOMAS SPLINT AND ITS MODIFICATIONS IN THE TREATMENT OF FRACTURES. By Meurice Sinclair, C.M.G., M.B., Ch.B.(Edin.). With a Foreword by Sir Robert Jones, K.B.E., C.B., F.R.C.S. New York: Oxford University Press, 1927.

THERAPEUTIC MALARIA. By G. de M. Rudolf, M.R.C.S., D.P.H., D.P.M. New York: Oxford University Press, 1927.

KER'S MANUAL OF FEVERS. Revised by Claude Rundle, O.B.E., M.D.(Lond.), M.R.C.S. (Eng.), L.R.C.P. (Lond.), D.P.H. 3d ed. New York: Oxford University Press, 1927.

DISEASES OF THE NEWBORN; A TEXTBOOK FOR STUDENTS AND PRACTITIONERS. By James Burnet, M.A., M.D., F.R.C.P. New York: Oxford University Press, 1927.

MANUAL OF THE DISEASES OF THE EYE; FOR STUDENTS AND GENERAL PRACTITIONERS. By Charles H. May, M.D. 12th ed. rev. New York: William Wood and Company, 1927.

POTASSIUM AND TARTRATES; A REVIEW OF THE LITERATURE ON THEIR PHYSIOLOGICAL EFFECTS. By Ralph W. Webster, Ph.D., M.D. With a Digest and Bibliography of the Literature by W. A. Brennan, A.B. Chicago: The Commonwealth Press, 1927.

CONTRIBUTE ALLA CHIRURGIA DEL RENE E DELL' URETERE. By F. De Gironcoli. Bologna: Licinio Capelli, 1927.

ARCHIVIO ITALIANO DI CHIRURGIA. Direttore: Mario Donati. Volume XVII. Scritti in Onore di Raffaele Bastianelli. Bologna: L. Cappelli, 1927.

SONDERBAENDE ZUR STRAHLENTHERAPIE. Band X. Physikalische Grundlagen der Lichttherapie. By Priv.-Doz. Dr. med. et. phil. H. Guthmann. Berlin and Wien: Urban & Schwarzenberg, 1927.

BIOLOGIE UND PATHOLOGIE DES WEIBES; EIN HANDBUCH DER FRAUENHEILKUNDE UND GEBURTSHILFE. By Josef Halban and Ludwig Seitz. Lieferungen 36 and 37. Berlin and Wien: Urban & Schwarzenberg, 1927.

PHYSICAL DIAGNOSIS. By Richard C. Cabot, M.D. 9th ed. New York: William Wood and Company, 1927.

THE OPERATIONS OF SURGERY. By R. P. Rowlands, O.B.E., M.S. (Lond.), F.R.C.S. (Eng.) and Philip Turner, B.Sc., M.S. (Lond.), F.R.C.S. (Eng.) 7th ed. vol. ii, The Abdomen. New York: The Macmillan Company, 1927.

SÉMÉIOLOGIE URINAIRE. By Oscar Mercier. Paris: Amédée Legrand, 1927.

THE MEDICAL DEPARTMENT OF THE UNITED STATES ARMY IN THE WORLD WAR. Vol. ii. Administration American Expeditionary Forces. Prepared under the Direction of Maj. Gen. M. W. Ireland by Colonel Joseph H. Ford, M.C. Washington: United States Government Printing Office, 1927.

THE DECLINE IN LEAD-POISONING. By Frederick L. Hoffman, LL.D. (Address Delivered Before the Health Congress of the Royal Institute of Public Health, Ghent, Belgium, June 1–6, 1927.)

INDUSTRIAL INSURANCE. By Frederick L. Hoffman, LL.D. (Address delivered before the Eighth International Congress of Actuaries, London, England, June 25–30, 1927.) Prudential Press, 1927.

SAN FRANCISCO CANCER SURVEY; FOURTH PRELIMINARY REPORT (Seventh and Eighth Quarterly Reports). By Frederick L. Hoffman, LL.D. Conducted under the auspices of the John Hancock Mutual Life Insurance Company, The Pacific Mutual Life Insurance Company, and The Prudential Insurance Company of America. Prudential Press, 1927.

LOS ACTUALES CONOCIMIENTOS DEL METABOLISMO MINERAL; ETC. By Dr. José M. Rosill. 2d part. Barcelona: Tipografia Emporium, S. A., 1927.